Chemical Engineering

A McGRAW-HILL PUBLICATION

MARCH 23, 1959

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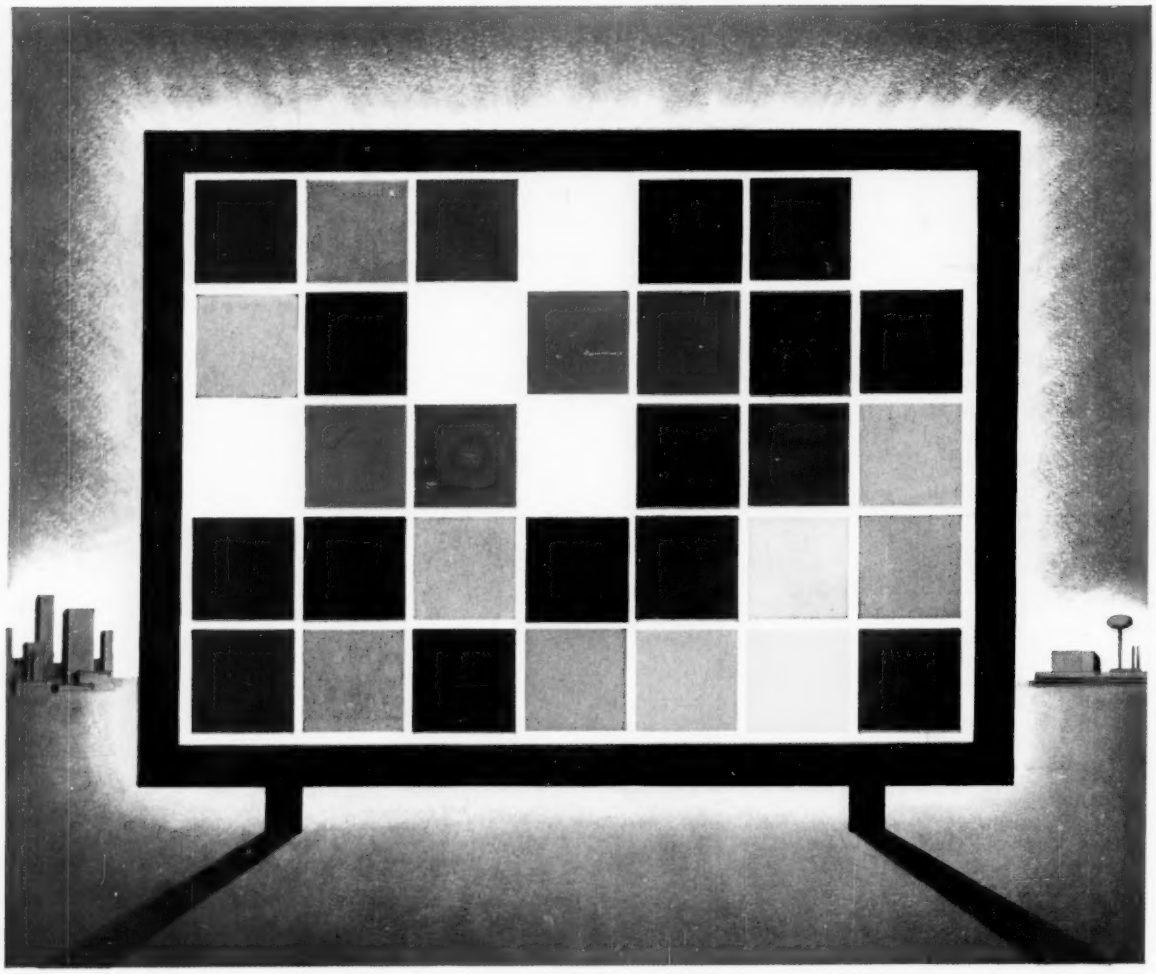
HOW AND WHEN TO USE...

PLASTIC PIPE

- Light weight; easy to install and repair
- Chemical resistance; low fouling tendency; low friction factor
- Savings on investment, on shipping, on external protection

HOW TO PICK THE RIGHT PLASTIC PIPE
GUIDE TO STEAM-JET EJECTOR CONTROL
ONE WAY TO BETTER SHELLSIDE HEAT TRANSFER

SEE PAGE FIVE



How Shell Chemical serves the surface coating industry

Shell Chemical has maintained for many years an active program of practical and theoretical research in oxygenated solvents and Epon® resins for surface coatings.

The result has been a better understanding of the effect of solvents on film formers—leading to superior performance and greater economy in surface coating formulations.

Epon resins are still another important outgrowth of Shell research. Surface coatings based on Epon resins are among the hardest, toughest, and most resistant to the attack of chemicals and corrosion ever developed.

Shell Chemical's Technical Service Laboratory offers you assistance in solving surface coating formulation problems. Write or phone your nearest Shell Chemical district office if we can be of assistance.

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SPROUT-WALDRON Pointers

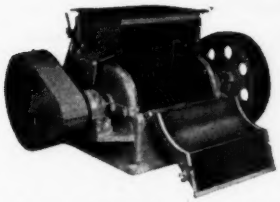
for Mixing and Blending • Size Reduction
Size Classification • Bulk Materials Handling • Pelleting and Densifying

Published in the interest of better processing by Sprout, Waldron & Co., Inc., Muncy, Penna.

PHENOLIC STOCK REDUCED IN SAW TOOTH CRUSHER

The reduction of calendered sheeting for phenolic molding compounds is being accomplished in a single pass through a heavy duty Sprout-Waldron saw tooth crusher. The warm material comes to the crusher in strips 6″ to 9″ wide, 12″ to 18″ long and in a variety of thicknesses. It is reduced to approximately ½″ square pieces.

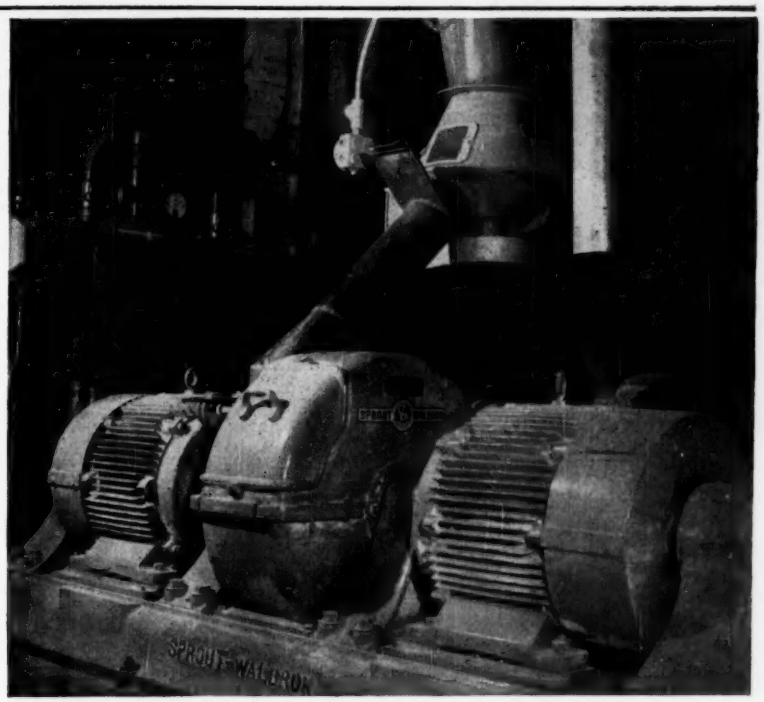
This precision-built heavy duty 16 x 25 Saw Tooth Crusher has been in successful operation at the General Electric Company plant in Pittsfield, Massachusetts for over 10,000 working hours, and it is still going strong. Its hard faced 16″ diameter breaker saws are designed specifically for the reduction of tough or brittle materials. In fact, everything about this crusher suggests high productivity under the most demanding conditions. Here are some of the key design points:



This Sprout-Waldron 16 x 25 Heavy Duty Saw Tooth Crusher has given more than 10,000 hours of satisfactory service in the crushing of phenolic stock at General Electric.

1. Precision-built.
2. Hinged covers to facilitate inspection or servicing.
3. Rugged construction. Alloy steel round shafts, mounted on large roller bearings.
4. Close fitting shrouds to prevent material by-passes.

For details, request Advance Specification Sheet No. 204.



STREAM SPLITTER KEEPS ATTRITION MILLS ON THE RUN

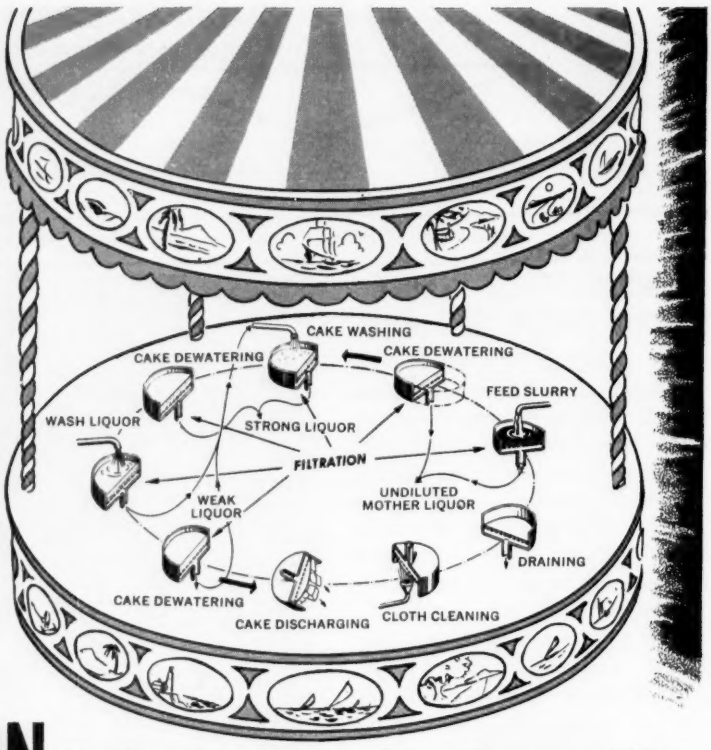
A few years ago the American Distilling Company installed a 26″ Sprout-Waldron double runner attrition mill for the grinding of corn, milo, rye, barley malt and other ingredients used in the production of Bourbon Supreme Whiskey, corn and rye whiskeys and grain neutral spirits. The mill discharged into a mechanical handling system consisting of a screw conveyor and bucket elevator.

As the need for expansion became obvious it was decided to install an identical Sprout-Waldron attrition mill to operate in parallel with the existing machine, providing greater flow rate, reduced wear and simplified maintenance.

The key to the new system is a Sprout-Waldron Model VA-5 stream splitter with two outlets which divides the flow equally between the two attrition mills. Four whole grain storage bins discharge to a common Sprout-Waldron 12″ x 18′ screw conveyor. The center outlet of the conveyor allows the grain to pass over a magnetic separator on the way to the stream splitter. As the ground grain emerges from the attrition mills it is conveyed to the roof of the building by a Sprout-Waldron 50 hp 44″ Pneu-Vac negative pressure system to another ground grain storage bin where it is held for further processing into quality whiskeys. For the facts on the Sprout-Waldron line of precision stream splitters, ask for Bulletin 137-B.

CP/106

Maybe You Should Put Your Product on this Money-Making MERRY-GO-ROUND



the BIRD-PRAYON Horizontal Tilting Pan Vacuum Filter

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whenever you need to keep volume of wash liquor at a minimum

whenever you encounter trouble with filter cloth wear or blinding; Bird-Prayon operation keeps the cloth always fresh and clean for uniform results as well as long service

whenever you need big filter area; the Bird-Prayon provides up to 560 sq. ft.

whenever you need corrosion-resistant construction

Ask for complete information, layouts and estimates. Pilot-scale test data is readily available from the Bird Research and Development Center

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Filtering gypsum from phosphoric acid — the Bird-Prayon attains high recovery of P_2O_5 with only 0.6 to 1.0 lb. of water per lb. of gypsum. Severe cloth blinding and corrosion problems have been overcome.

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Uranium pulp is being filtered by the Prayon to recover 99% of the solubles after acid leaching. Only .75 lb. of wash water per lb. of dry solids.

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Chemical Engineering

MARCH 23, 1959 **Vol. 66, No. 6**

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SIXTH OF TWENTY-SIX 1959 ISSUES

6/26

Latest facts about today's plastic pipe

Plastics often have advantages over metals in process piping. Now you can get to know what may and what may not be done with these materials today. Your CE report presents down-to-earth engineering information about today's plastics. It separates fact from fiction about materials, properties, costs, installation, the advantages and the disadvantages. (p. 149)

Five ways to control ejector pressure

How to set up a vacuum control system for steam jet ejectors. How you can get smooth and flexible pressure control by accommodating your own equipment's operating characteristics. (p. 171)

Tip on using heat exchangers

It may be traditional, but it's not necessarily most economical to put the more viscous fluid into the tubes of your heat exchangers. It's possible, in some cases, to double heat transfer by switching to the shell. (p. 175)

Now you can compare your salary

Of the 190,810 engineers whose salaries are reported in the latest survey, those who work for chemical employers are paid best. You may not realize it, but now you are better off than even petroleum or aircraft engineers. And that's a new twist. (p. 188)

A step up in safety...

BLAW-KNOX Electroforged® Steel Grating and Treads

Indoors or outdoors the safe way to build a walkway is with Blaw-Knox Electroforged steel grating. Nonslip twisted crossbar provides the safest possible surface. Self-cleaning, steel grating does not collect dirt or grease . . . provides maximum open area for light and ventilation.

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For more detailed information about how to order Blaw-Knox Electroforged steel grating and treads for your needs, send for your copy of Blaw-Knox Bulletin number 2527.

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Chemical Engineering

MARCH 23, 1959 **Vol. 66 No. 6**

Edited for the engineers who develop, design, build, operate, maintain and manage chemical operations of all types. More engineers subscribe to CE than to any other magazine in the field. Print order of this issue: 49,161.

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*Check your Reader Service postcard (p. 171) for free copy of this guide to setting up a vacuum control system for steam jet ejectors.

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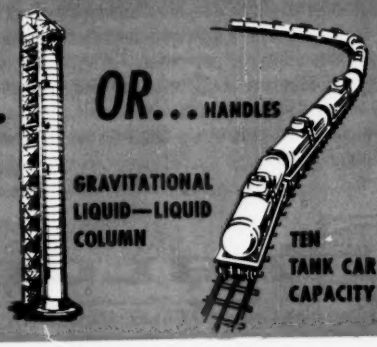

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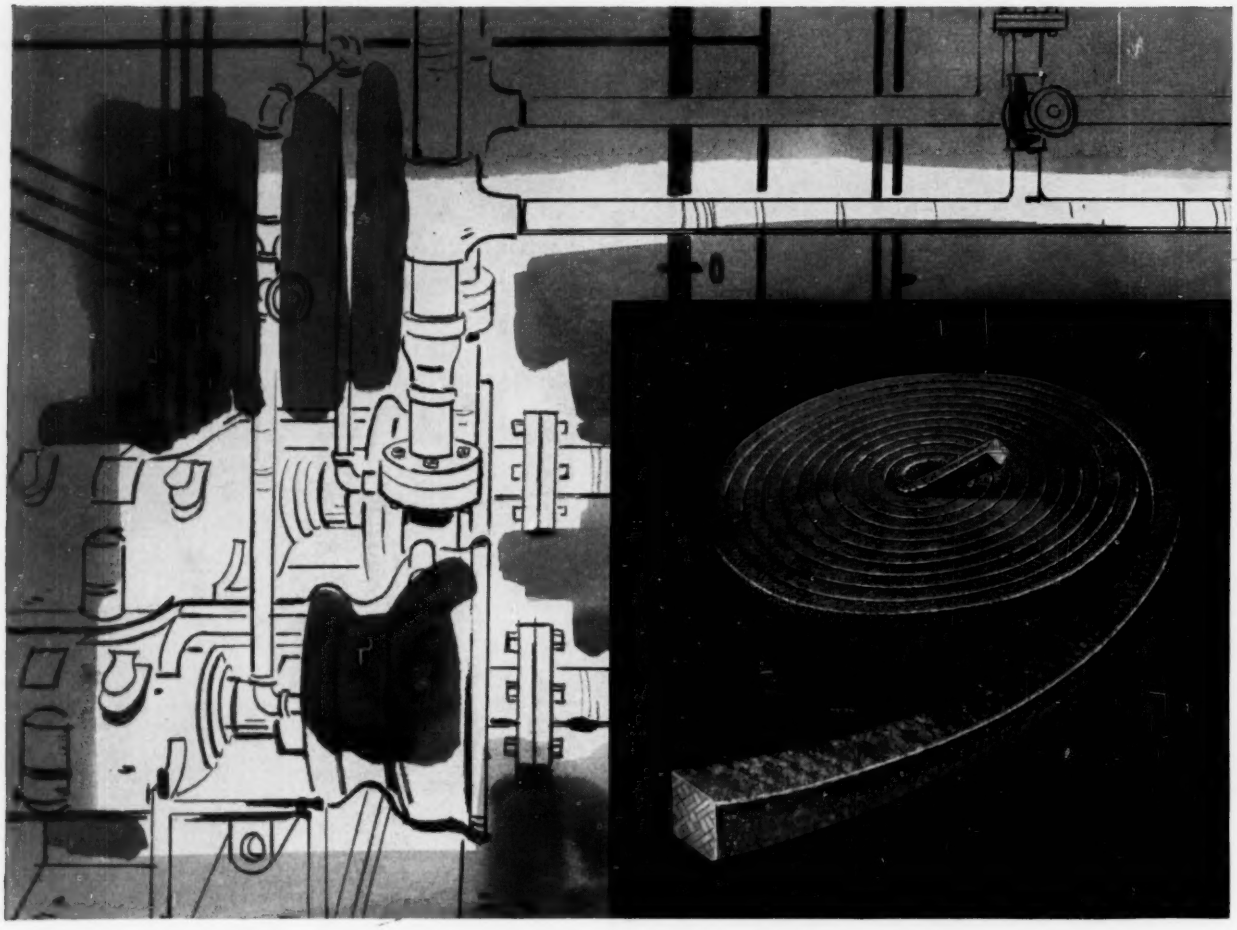

"LATTICE-BRAID* TEFLON† PACKING IS YOUR BEST BET FOR PUMPS AND ENGINES"

"LATTICE-BRAID TEFLON is just about perfect against chemicals—it's a strong, long-lasting, chemically-inert packing that reduces maintenance and downtime. Let me show you what I mean.

"With LATTICE-BRAID packing, each strand passes diagonally through the body of the packing at a 45° angle. This through-and-through braiding makes a completely unified structure of *greater strength*. Ordinary braided packings become worthless once the single outer cover is worn through. On LATTICE-BRAID, there is no single outer cover; thus, the braiding holds together far beyond the limits of other packings. This, obviously, results in *longer life*.

"On top of this, you have the advantage of TEFLON. It is completely unaffected by the strongest acids, solvents, and alkalies. Co-efficient of friction is extremely low, and it will withstand temperatures ranging from −90° F to +500° F.

"One customer repacked every two weeks on a solvent recovery pump application. He changed to LATTICE-BRAID TEFLON over two years ago and hasn't repacked since."

Garlock can furnish you with LATTICE-BRAID packing in a variety of sizes and styles depending on what you need. If you have a particular problem, call our sales office in your area. Or, you can write for further information. Ask for Catalog AD-131.

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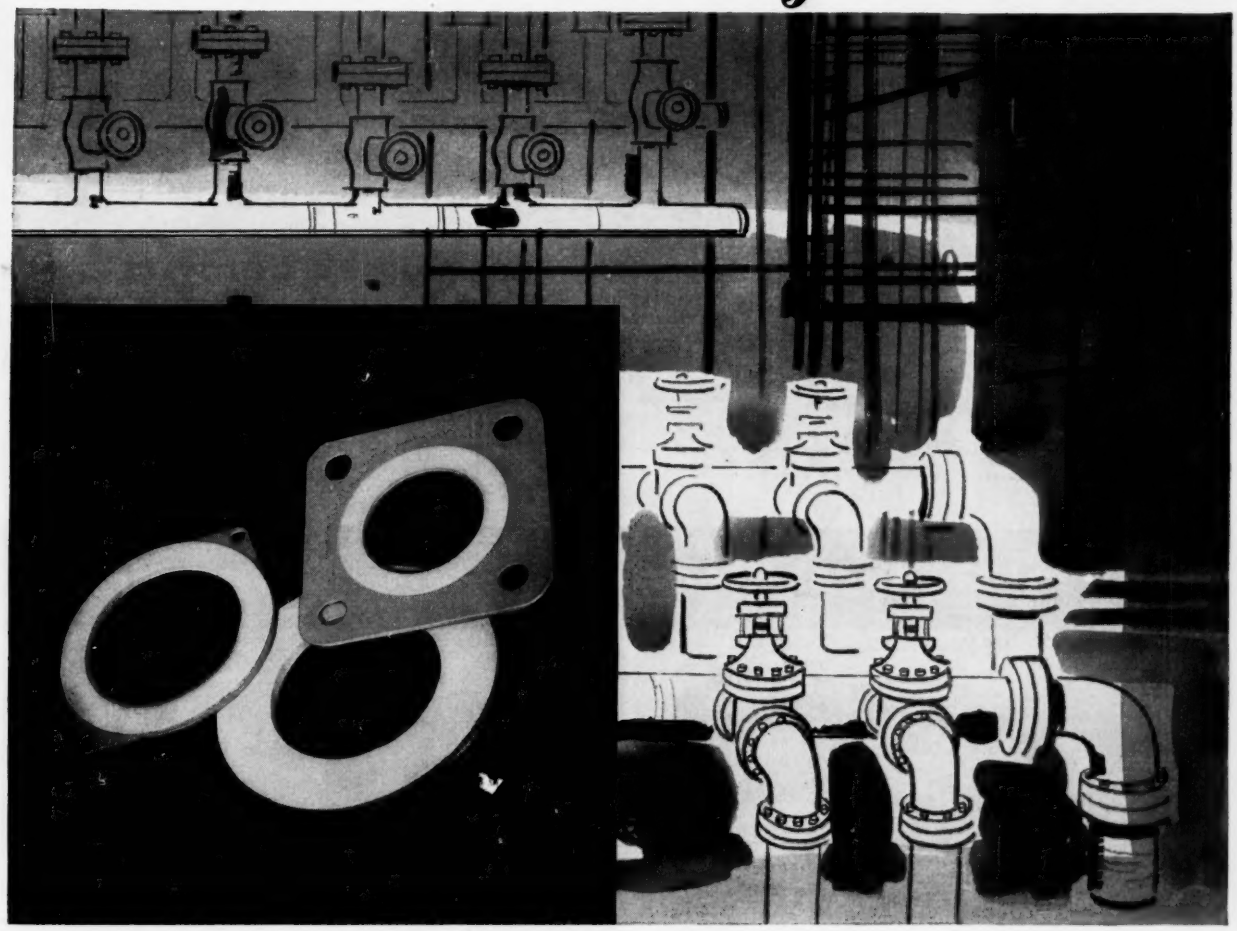


"BUY LONG-LASTING TEFLON GASKETS FOR PIPING, FLANGES AND FITTINGS"

"With TEFLON jacketed gaskets the outstanding advantage is that you get the fine qualities of TEFLON without sacrificing resiliency and deformability. This, of course, is extremely important on your glass-lined steel piping and process equipment, light metal flanges, and glass pipe flanges and fittings.

"The first step in choosing the proper gasket is to select the type which will work best for you. TEFLON-jacketed gaskets come in four basic designs:

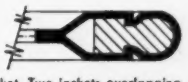
"Once this design is chosen, it's a matter of considering the filler material and thickness. For example, for high pressures, a corrugated stainless steel filler is suggested. Where the application is for glass-lined steel connections with low bolt loads, a rubber filler should be sandwiched between woven asbestos cloth. We offer many different types of fillers, depending on what you need—rubber, asbestos, cork, etc."

Why not let our representative in your area help you select the right gasket design? Discuss your problem with him or write for our Catalog AD-154.

A: Slit Envelope. Teflon stock slit from outside diameter to within ⅛" of inside diameter.

B: Milled Envelope. Teflon stock machined from outside diameter to within ⅛" of inside diameter. Gasket I.D. does not interfere with process flow.

C: Formed Shield for large diameters and irregular opening such as elliptical manholes.



D: Double Jacket. Two jackets overlapping to protect O.D. as well as I.D. For glass-lined steel nozzles.

THE GARLOCK PACKING COMPANY, Palmyra, N. Y. For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U. S. and Canada.

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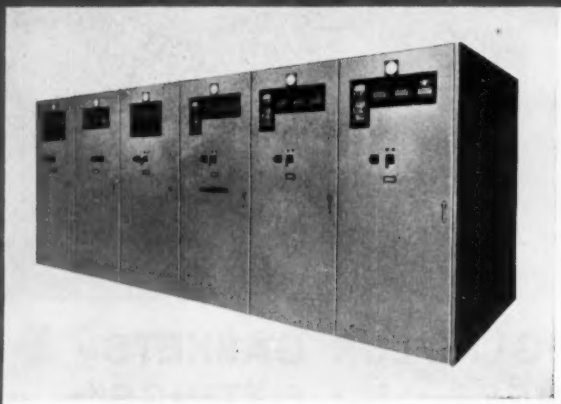
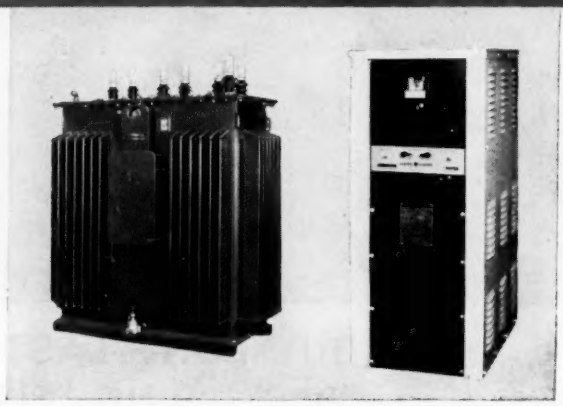
Designed to provide up to 96% efficiency, General Electric semiconductor power rectifier systems offer reliable, economical power conversion for the electrochemical industry

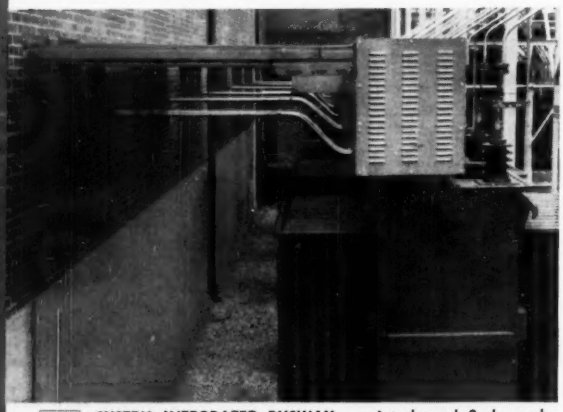
Typical General Electric Rectification System:



1 **SYSTEM COORDINATED** General Electric metal-clad switchgear equipment handles normal switching functions and provides dependable a-c short-circuit protection.



2 **LIQUID IMMERSED** (l.) or dry-type (r.) Inductrol® voltage regulators compensate for system regulation and a-c supply variations to provide d-c control at desired voltage levels.



4 **SYSTEM INTEGRATED BUSWAY**—an interleaved 3-phase design completes connection to rectifier. Busway provides greater flexibility . . . reduced installation costs.

5 **COMPACT, EFFICIENT** rectifier sections convert alternating current to direct current for process requirements. D-c current transformers, mounted on d-c buses, measure output.

In the last few years, General Electric has supplied semiconductor power rectifier systems for over 85 electrochemical installations. Users report that these systems—designed to provide over 90% efficiency above 15 volts d-c, and from 94 to 96% efficiency above 60 volts d-c—have increased system reliability and reduced installation and operating costs.

Coordinated System Components Provide Peak Performance, Longer Life—Because each electrochemical facility requires special d-c voltages for its particular process needs, power rectifier systems should be tailored to each installation for maximum reliability and economy. For this reason, General Electric manufactures all major power rectifier system components—including air-cooled and water-cooled, germanium and silicon rectifiers—and is fully equipped to provide installation and service assistance on all components.

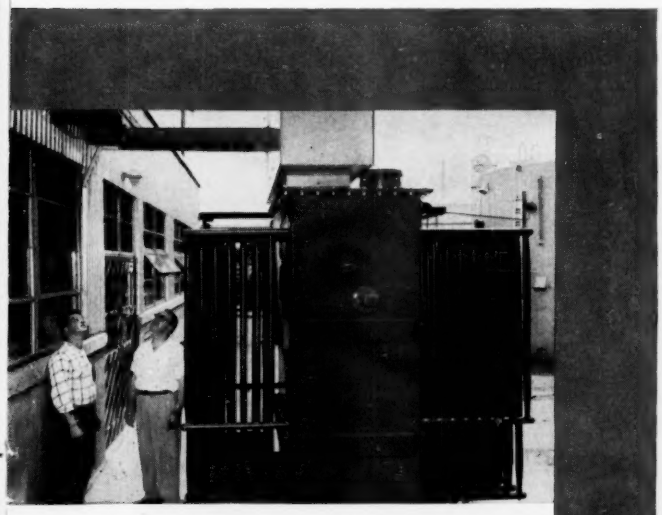
G-E Semiconductor Power Conversion Systems Find Wide Application—Due to their greater efficiency and economy, General Electric rectifier systems have enjoyed widespread acceptance as d-c power sources in hydrogen, chlorine and fluorine plants; copper refining, aluminum reduction, tin-plating, chrome-plating and aluminum anodizing processes; and for powering d-c motors. New uses for these versatile dependable power conversion systems are continually being developed.

For Complete Information on General Electric *system-engineered* and *performance-proven* semiconductor power rectifier systems, contact your nearby General Electric Apparatus Sales Office. Your G-E sales representative can help specify semiconductor power rectifier equipment specifically tailored to your process needs.

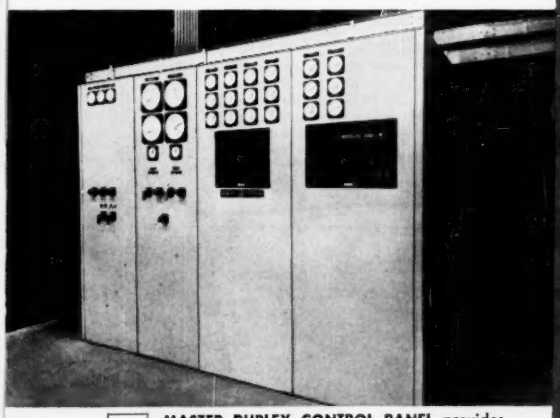
Write G-E Co., Section 686-1, Schenectady 5, New York, for These Free Bulletins: GEA-6684, Semiconductor Rectifier Power Conversion Systems for Electrolytic Processes; GEA-6375A, Semiconductor Power Rectifiers.

Engineered Electrical Systems for the Electrochemical Industry

GENERAL ELECTRIC

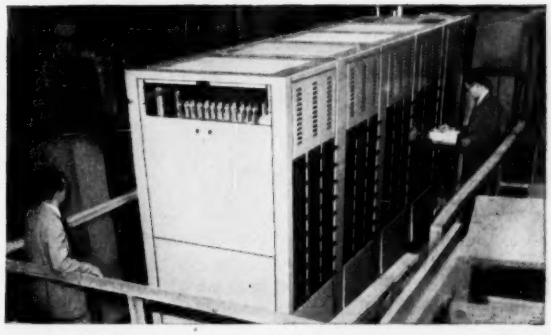


3 **G-E RECTIFIER TRANSFORMER** gives proper ratio of a-c primary to desired conversion voltage . . . can be located out-of-doors.

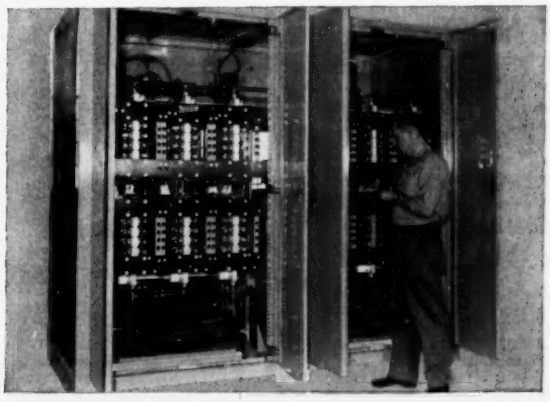


6 **MASTER DUPLEX CONTROL PANEL** provides centralized instrumentation and control of complete G-E power conversion system.

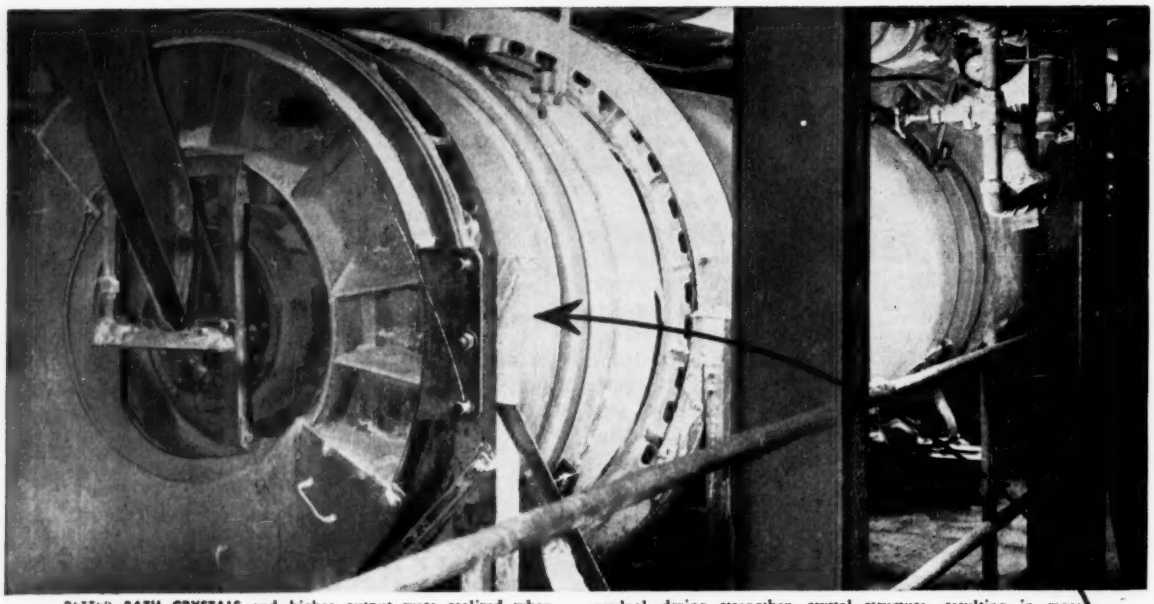
General Electric Offers Both Air and Water-cooled Rectifiers



G-E AIR COOLED semiconductor power rectifiers are recommended for systems where d-c voltages exceed 400 volts. Trays contain several series rectifier cell assemblies, fuse, fuse monitor and indicating lights.



DIRECT WATER-COOLED G-E rectifier units are used in systems where d-c voltages do not exceed 400-v. Internally mounted air-cooled transformers (above) are sometimes used in smaller systems.



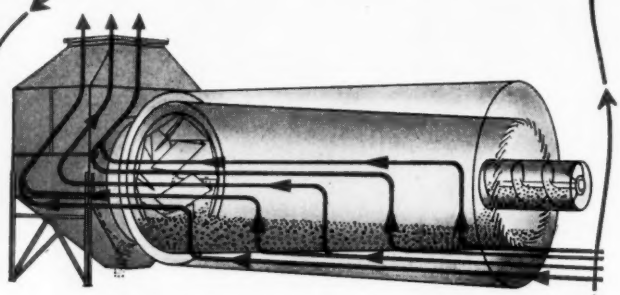
BETTER BATH CRYSTALS and higher output were realized when a leading chemical producer installed this Link-Belt Roto-Louvre dryer at their northern Ohio plant. Uniform aeration and controlled, gradual drying strengthen crystal structure, resulting in more pleasing appearance. Gentle handling eliminated crystal degradation.

Repeat laboratory precision in full-scale production

with the LINK-BELT Roto-Louvre dryer

YES, it's easy to duplicate the quality of laboratory test samples on production runs using a Link-Belt Roto-Louvre dryer. Accurate "scale-up" is readily achieved because of Roto-Louvre's unique design and precisely controlled drying.

Compact and highly effective, this machine introduces dry, heated air through ever-changing channels, exposing the entire surface of every particle to uniform treatment. For facts, send for Book 2511. Or, if you prefer, send a sample of your material and we'll work out drying, cooling or roasting procedures you can duplicate in your own plant.



Common-sense design assures effective heat transfer

Roto-Louvre has largest volume of air penetrating thin bed of material near feed end, where greatest evaporation must take place. As material moves forward and bed becomes thicker, smaller air passages reduce volume of air passing through bed, preventing overheating. Precise control of input air temperature, exhaust and conditions of material travel assures maximum heat transfer per cubic foot of air.

LINK-BELT

DRYERS • COOLERS • ROASTERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,564

LINK-BELT COMPANY
Prudential Plaza, Chicago 1, Ill.

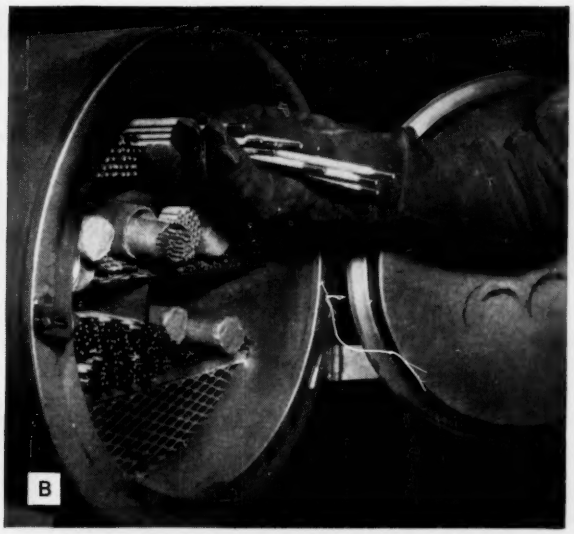
Please send me 20-page Roto-Louvre Book 2511.

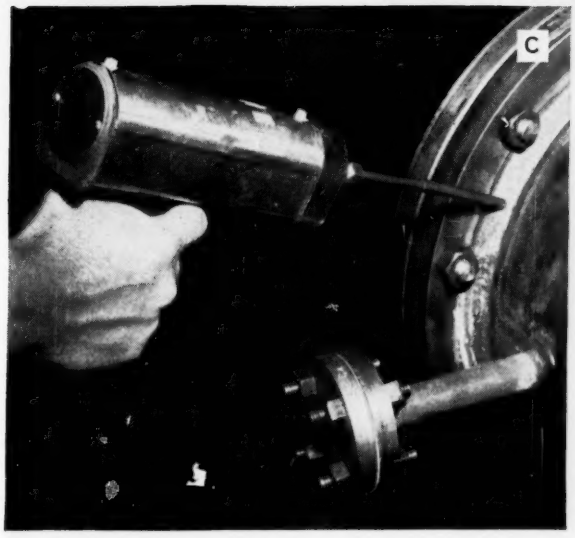
Name .....

Firm .....

Address .....

City..... Zone... State.....





Modern techniques bring new benefits

Whatever is new in metallurgy, welding, or testing is sure to absorb the attention of Downingtown experts—especially when it helps us produce better processing equipment for you. Here are some of the modern techniques you would see on a trip through our shop. Write for handy index to the ASME Code.

A **Skin-deep**—When paint thickness is vital to product protection against corrosion, this instrument tells us exactly how thick the paint application is.

B **Fresh from the oven**—Heated to 250°F to drive out water vapor, these welding electrodes won't contaminate weld metal or adjacent plate with water-released hydrogen.

C **Sniff! Sniff!**—No leaks here... if there were, the Halide leak detector would react fast as it sniffs the seams and joints of a vessel pressurized with gas.

D **A penetrating analysis**—Special dye, sprayed on weld after back-chipping, reveals microscopic cracks so they can be eliminated before weld is completed.

Downingtown Iron Works, Inc.

140 Wallace Ave., Downingtown, Pennsylvania

division of **PRESSED STEEL TANK COMPANY** Milwaukee

Branch offices in principal cities

HEAT EXCHANGERS—STEEL AND ALLOY PLATE FABRICATION
CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

CYANAMID

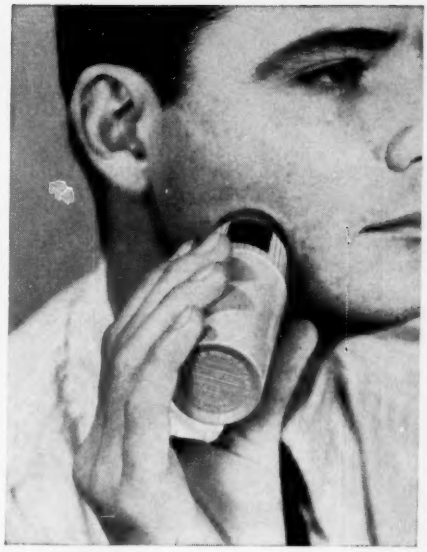
Chemical Newsfront

HYDRAULIC FERTI-SEEDING IS A NEW METHOD being used to seed and fertilize highway slopes on the new Connecticut Turnpike. Seed and fertilizer are mixed with water and sprayed on slopes by the equipment shown. One filling covers 65,000 square feet in 20 minutes. It is estimated that hydraulic seeding will save well over $1 million in the initial seeding of the 129-mile Turnpike. The even distribution of seed and fertilizer far surpasses that of any manual or mechanical method ever employed by the Connecticut State Highway Department. The use of bulk urea, triple superphosphate and muriate of potash for use in this equipment reduces fertilizer handlings as much as fifty percent. **(Agricultural Division)**

MORE EFFICIENT CLEANING COMPOUNDS for rugs and upholstery can be made with AEROSOL® 22 *Surface Active Agent*. In either dry or wet cleaners, the low wetting properties of AEROSOL 22 at room temperature prevent wetting-out of fabrics. Dirt is thus removed from the surface, not forced into the fibers. AEROSOL 22 can be readily absorbed onto sawdust or other fillers, or incorporated in filler pastes or liquid solvent solutions.
(Industrial Chemicals Division)

NEW CORDLESS ELECTRIC SHAVER features light-weight (two ounces), damage-resistant case of CYMEL® *melamine plastic*, designed by Raymond Loewy Associates. This smart-looking Universal shaver operates anywhere on ordinary penlight or transistor batteries. The CYMEL case is contoured to fit the hand, corrugated at the top for a natural, easy grip. CYMEL resists breaking, chipping, scratching, perspiration, and corrosion from shaving lotions and battery chemicals. Color, molded in, can't chip or wear off.

(Plastics and Resins Division)



EASING PRODUCTION OPERATIONS for rubber manufacturers is a new *flaked* version of the popular vulcanization accelerator, *N-Cyclohexyl benzothiazole-2-sulfenamide*. Inherently free flowing, CYDAC* *Accelerator Flaked* has virtually eliminated dusting, caking and bridging problems encountered in using powdered material. The result is cleaner handling and quicker, more accurate weighing. CYDAC is also particularly well-suited for use in the automatic compounding equipment which is finding increasing use in the rubber industry. **(Organic Chemicals Division).**

GELS FROM SYSTEMS OF LOW VISCOSITY can be produced with CYANOGUM* 41 *Gelling Agent*. When introduced into cement-sand mixtures, CYANOGUM 41 will produce stiff gels in a predetermined time. The photograph above shows the difference in gelation between an unmodified cement-sand mixture, left, and one gelled by CYANOGUM 41, right, after 5 minutes elapsed time. In concrete aggregates, latex, and in dispersions of solids, shorter gel times may improve the economics of manufacture of molded or cast products. CYANOGUM 41 can be placed and gelled virtually anywhere that water can be introduced.

(Market Development Department)

*Trademark

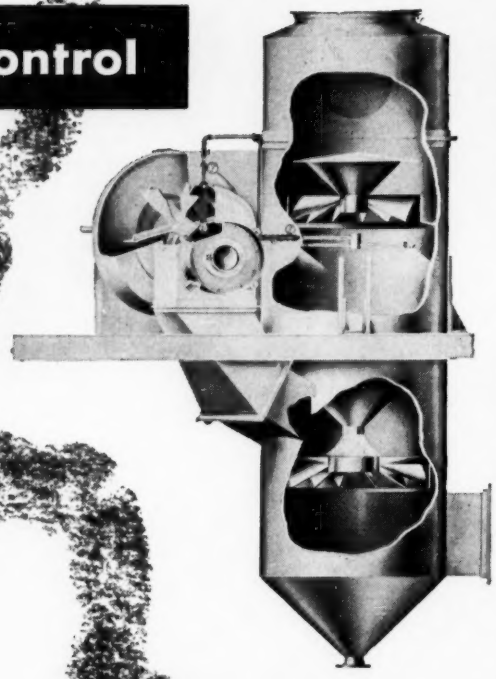
CYANAMID

AMERICAN CYANAMID COMPANY

30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

For further information on these and other chemicals, call, write or wire American Cyanamid Company

. . . in wet dust control



NEW DUCON DYNAMIC WASHERS

Patented

RECOVER DIFFICULT DUSTS EFFICIENTLY AND ECONOMICALLY

Ducon UW-4 Dynamic Wet Dust Collectors have added a new dimension in dust recovery. They have replaced, with outstanding success, many more costly and less effective dust collectors in the recovery of "difficult" materials, such as fine and abrasive dusts in kilns, rotary driers and other applications.

The UW-4 Washers are also ideal for high loading conditions where maximum efficiency is desired.

Ducon UW-4 washers offer other unique advantages, including constant air capacity, low water consumption and rugged construction. They are self-cleaning and fire and explosion proof.

For complete information write for Bulletin W-7456.

DUST CONTROL SYSTEMS AND EQUIPMENT — DUCON

the name in DUst CONtrol

THE Ducon COMPANY INC.

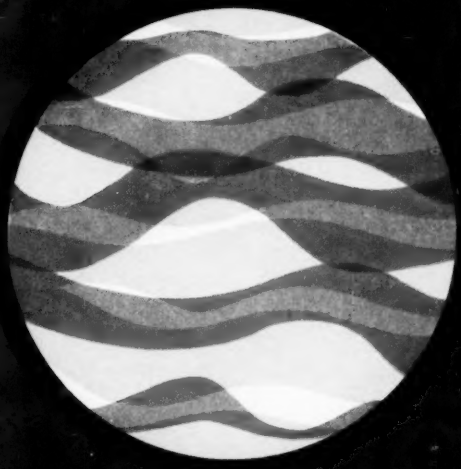
147 EAST SECOND STREET • MINEOLA, L. I., NEW YORK

Canadian Branch:
THE DUCON COMPANY of CANADA, Ltd.,
1131 Pettit St., BURLINGTON, ONTARIO

CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES

OBSTRUCTIONLESS FLOWMETERING

from a trickle...
to a torrent



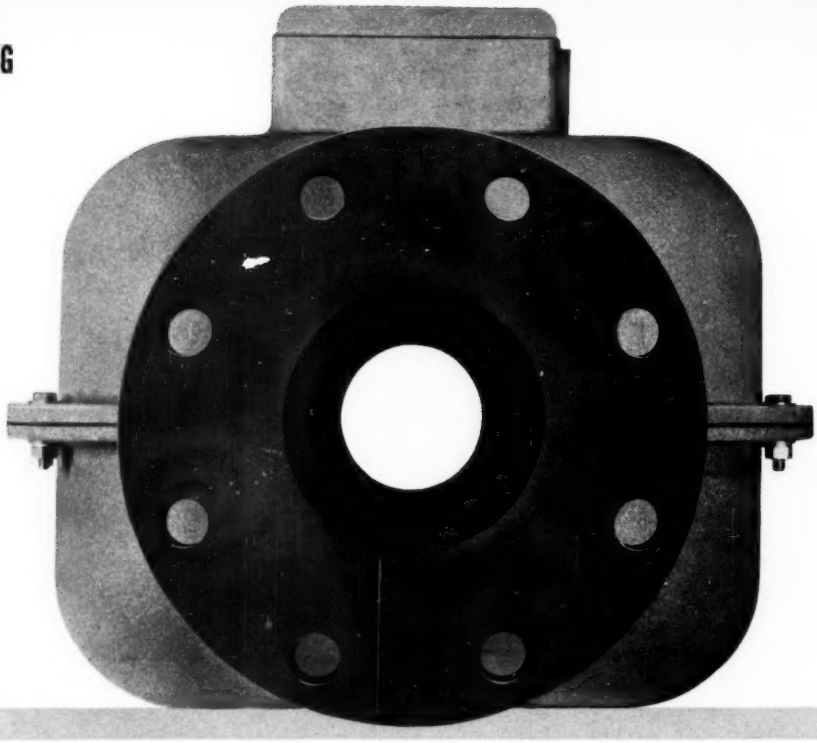
FP

F&P MAGNETIC FLOWMETER

lets you set any flow at full scale . . . from 1 to 30 fps

PROVED IN CHEMICAL PROCESSING

The perfect path for corrosive media. Tough, inert liners withstand acids, alkalies, solvents . . . even rough abrasive slurries.



A turn of a dial gives you full-scale recording for *any* flow rate from 1 to 30 feet per second and permits operation at optimum chart position. This flow range flexibility costs you no more . . . it's an "extra" that's built into every *Fischer & Porter* Magnetic Flowmeter.

If you want to check our claim that F & P gives you more meter for the money, take a good look at these additional exclusives:

- *Any* primary is interchangeable with *any* secondary . . . no custom matching of meter to recorder.
- Remote recording up to 2000 feet from the meter.
- Power requirements substantially reduced . . . 117v, 60 cycle a-c in *all* sizes.
- Can measure reverse flows *without auxiliary equipment.*
- Fast response time . . . 2-3 seconds full scale.
- Adjustable damping of flow signal.

Before you buy *any* magnetic flowmeter, investigate the advantages of F & P's magnetic flowmeter. Get in touch with the F & P field engineer nearest you and write for Catalog 10D1416. Fischer & Porter Company, 139 County Line Road, Hatboro, Pa. In Canada, write Fischer & Porter (Canada) Ltd., 2700 Jane Street, Toronto, Ontario

FP FISCHER & PORTER COMPANY *COMPLETE PROCESS INSTRUMENTATION*

Tailor-made, tough and chemically inert...

. . . these J-M Chempac Teflon components combat chemical and solvent action!*

SMALL OR LARGE . . . intricate or simple . . . J-M Chempac® Teflon components have proved their exceptional resistance to the constant attack of corrosive chemicals in rugged service.

Look to J-M for Teflon packings, gaskets, and moulded shapes made to your exact specifications . . . or for parts that are machined to close dimensional tolerances. Moreover, we can combine Teflon with top quality J-M asbestos to impart the exceptional sealing and heat-resistance properties of the "magic mineral." And in addition to corrosion-resistance, Teflon gives you the advantages of an extremely low coefficient of friction . . . toughness and flexibility . . . and weight-saving possibilities.

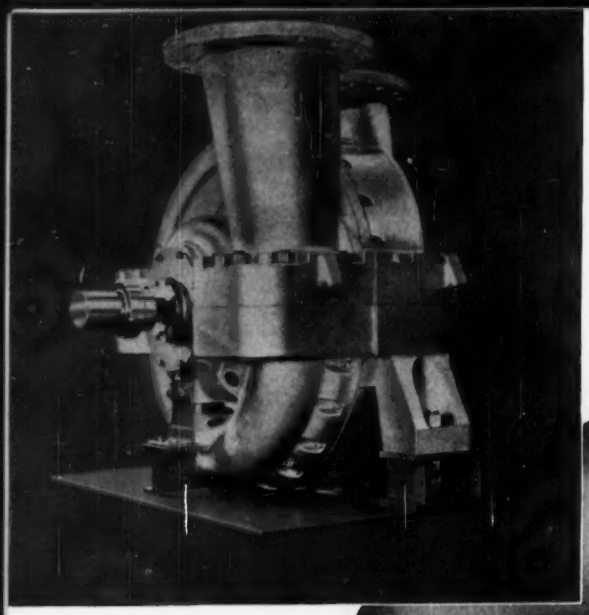
You can also obtain J-M Chempac Teflon Packings in moulded and braided types for pumps and valves . . . in a wide range of flange and envelope-type gaskets . . . in rings, cups, sheets and tapes. Your J-M Packings Distributor can supply your needs. Or write Johns-Manville, Box 14, New York 16, New York. In Canada: Port Credit, Ontario.

*TM for DuPont Tetrafluorethylene resin.

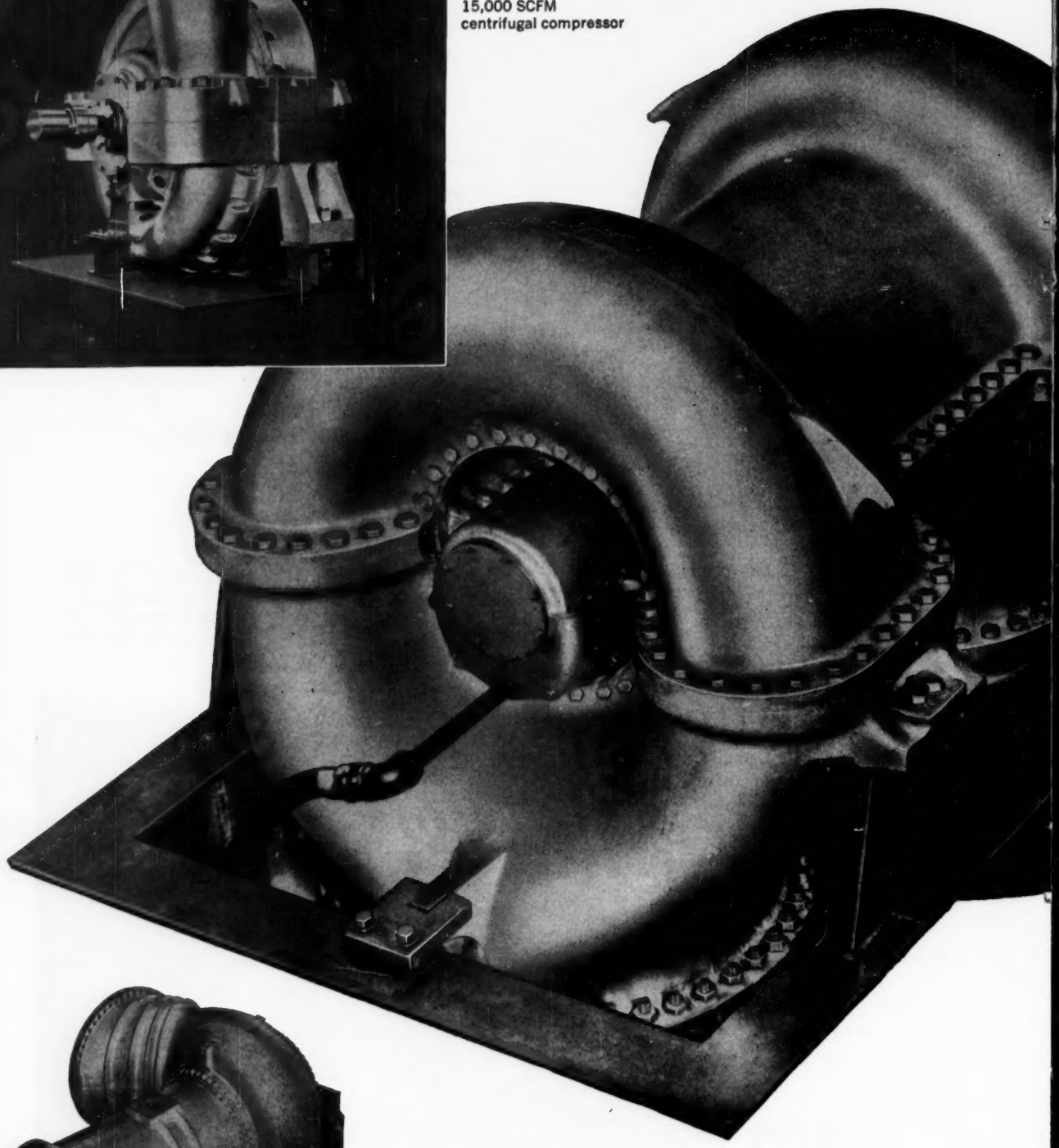
Teflon rods, tubes, tapes and sheets —in addition to components of varied sizes and shapes as indicated here—are also available from Johns-Manville. Prompt delivery of any quantity you need is assured by new J-M production facilities.

JOHNS-MANVILLE JM PRODUCTS

JOHNS-MANVILLE



15,000 SCFM
centrifugal compressor



104,000 SCFM, 6000 hp
axial compressor operating
with 1100° inlet temperatures
and 200 psia inlet pressure.

125,000 SCFM,
15,000 hp, eight—stage
axial compressor

HIGHER

stage performance and efficiency in Joy axial and centrifugal compressors— what it means to you

Lower Initial Costs
Higher performance per stage means fewer parts and lower manufacturing costs.

Lower Operating Costs
Higher stage efficiencies result in a higher over-all compressor efficiency, which means lower power requirements and reduced cooling water needs.

Smaller Size
Higher performance per stage means fewer stages and smaller over-all dimensions for the compressor cases. This results in a considerable saving of floor space and smaller headroom requirements.

Less Weight
Fewer stages and smaller cases mean a considerable saving of weight, with a reduction in foundations, column size, floor loading factor, and vibration.

Increased Reliability
Fewer stages mean fewer inter-stage seals, shorter and more rigid rotors, lower bearing loads and reduced differential expansion of cases and rotors. Write for full details on how the advanced Joy axial and centrifugal designs can save you money on your compressed air requirements. Ask for Bulletin 277-11

W&W I 7400-277

AIR MOVING EQUIPMENT FOR ALL INDUSTRY

JOY

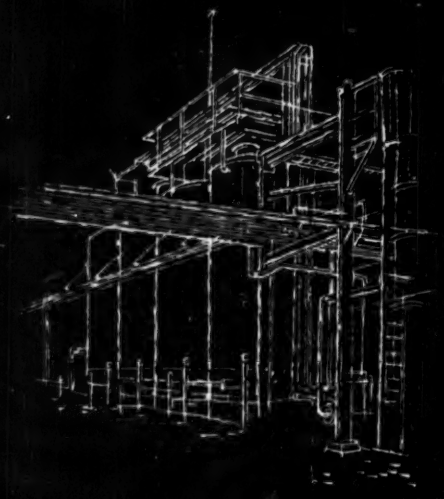
Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

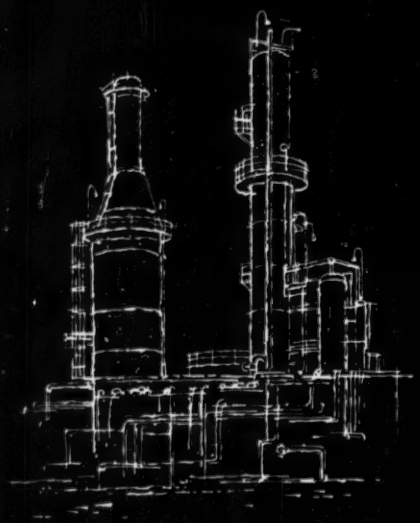
In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

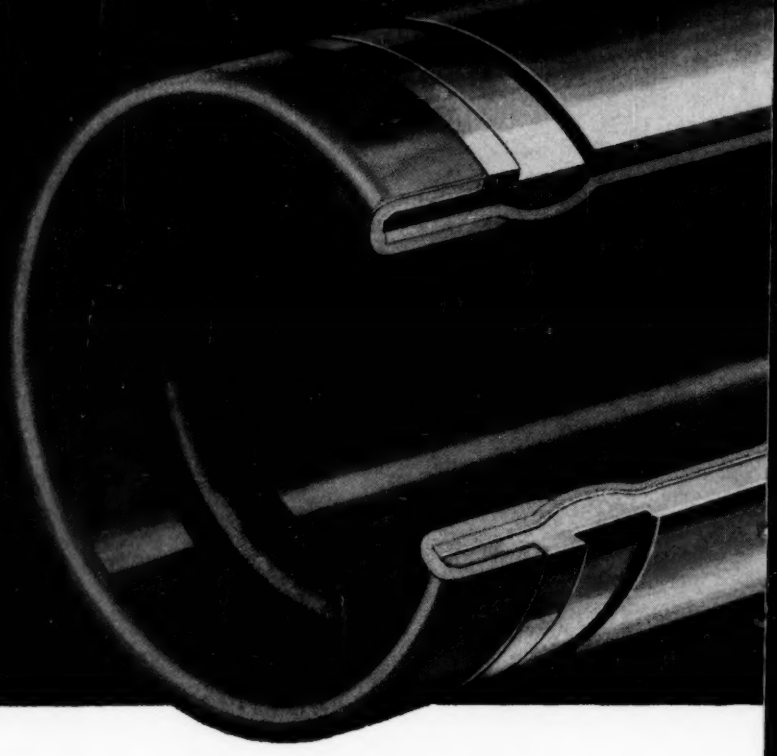
NEW "JAL-

handles corrosive liquids

- at pressures to 1000 P.S.I.
- at temperatures to 150°F.







New "Jal-Jacket" pipe, combining the corrosion resistance of rigid polyvinyl chloride with the strength of steel, offers you these cost-cutting advantages in handling corrosive liquids.

LOW INITIAL COST. "Jal-Jacket" pipe costs less than other lined metal pipe.

LOW COST INSTALLATION AND MAINTENANCE. Ends grooved for Victaulic couplings permit quick, easy make-up. Entire systems can be dismantled and re-assembled without damage to the PVC lining. "Jal-Jacket" can be cut to length and joined on the job. Requires no troughs or other costly supporting devices.

LONGER SERVICE LIFE. Plastic liner is bonded securely to the steel jacket. The ends are fully protected with plastic providing continuous protection from chemical attack. Steel jacket assures a tough, rugged product.

Jones & Laughlin Steel Corporation

PITTSBURGH, PENNSYLVANIA

JACKET" PIPE*

J&L STEEL

*a rigid unplasticized polyvinyl chloride tube jacketed with electric-resistance welded steel pipe.

"Jal-Jacket" is currently available in 20 foot mill lengths in three sizes, 2⅜", 3½", 4½" O.D. Get complete details by mailing this coupon today.

Jones & Laughlin Steel Corporation
3 Gateway Center, Pittsburgh 30, Pa.

☐ Send information on "Jal-Jacket"
☐ Have J&L representative call

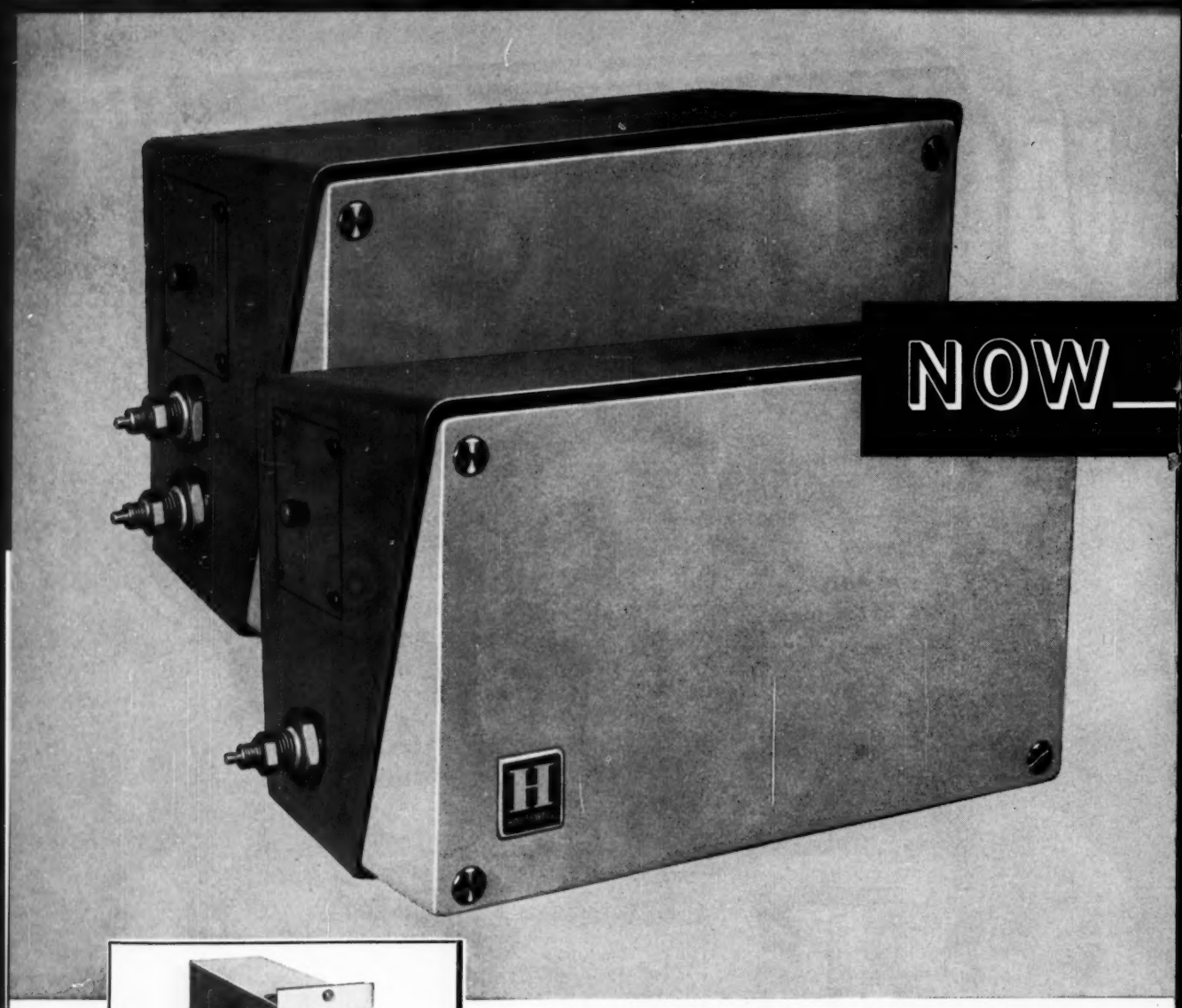
Name_____

Title_____

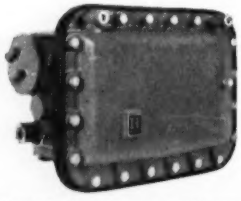
Company_____

Street_____

City_____ State_____



RELAY RACK MOUNTING permits four transducers to be mounted abreast on a standard 19-inch-wide relay rack with 7-inch vertical spacing.



EXPLOSION-PROOF HOUSING meets conditions of operation specified under Class I, Group D, Division 1 of the National Electrical Code.

WEATHERPROOF HOUSING is diecast aluminum, dust-tight, splash-proof, for indoor or outdoor mounting. Supplied with vertical surface mounting accessories. Valve or pipe mounting bracket accessories available. This housing meets Class I, Group D, Division 2 requirements of the National Electrical Code.

	P/I TRANSDUCER	I/P TRANSDUCER
Input	3-15 psi	4-20 ma d-c
Output	4-20 ma d-c	3-15 psi
Accuracy	±¼% of span	±¼% of span
Ambient temperature range	−40° to +150°F	−40° to +150°F
Maximum load resistance	800 ohms	————
Supply	42 ±2 V d-c	20 psi
Air Consumption	————	less than 0.35 cfm

adapt your pneumatic loops to centralized, electric control with *ElectriK Tel-O-Set** TRANSDUCERS

Now, get the desirable advantages of electric control with your present *pneumatic* instruments. New *ElectriK Tel-O-Set* transducers let you make use of modern data processing techniques . . . centralize multi-plant control . . . and bring additional facilities into your control system.

The P/I (pressure-to-current) transducer converts the standard 3-15 psi signal of your present pneumatic instruments to a standard electric signal which is fed to the electric control center. Its counterpart, the I/P (current-to-pressure) transducer, converts the signal from the electric control center back to the standard 3-15 psi signal which is fed to the pneumatic control loop. Used together with your present pneumatic instruments, they permit long-distance, high-speed electric transmission of process variables, eliminating the lags characteristic of extremely long runs of pneumatic tubing.

These twins have a calibrated accuracy of $\pm \frac{1}{4}\%$ of span. They're completely transistorized for long, reliable service. Only two wires, forming a series circuit between transducer and receiver, are needed to carry the signal and line power is not required in the field. Both units are trim, compact, and easily installed, adjusted and maintained.

Get complete details from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

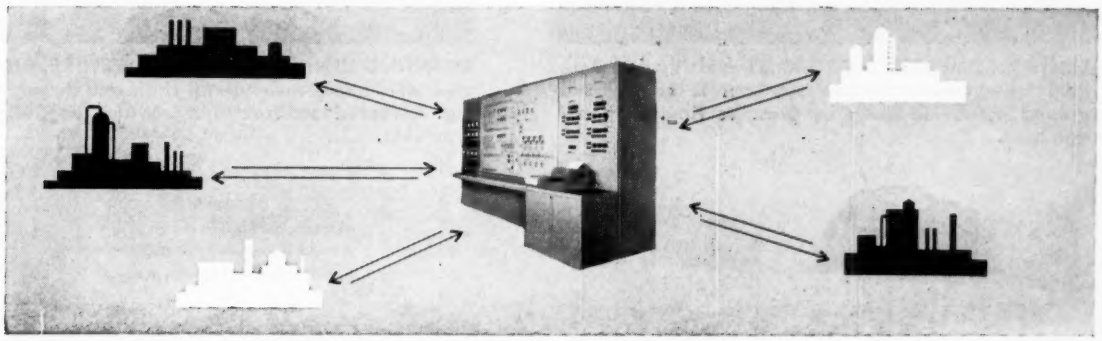
MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

*Trademark

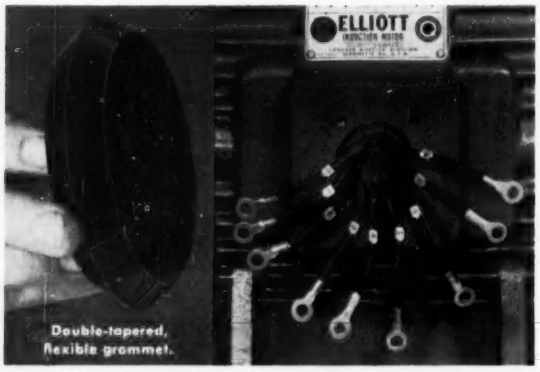
Honeywell

H HONEYWELL *First in Control*

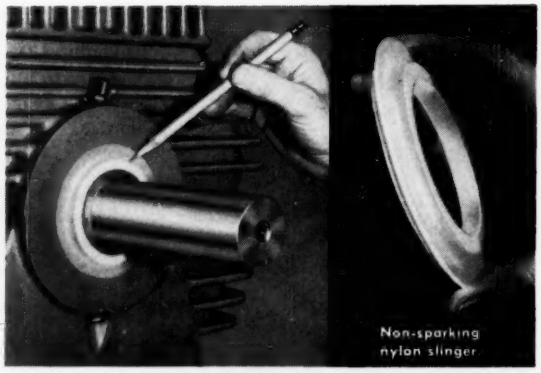
Diagram symbolizes use of transducers in a "wheel-type" plant to convert signals from existing pneumatic instruments to electric signals for data processing or electric control. White silhouettes represent future plants.



better protection and better cooling make Elliott C-W SEALEDPOWER MOTORS outstandingly



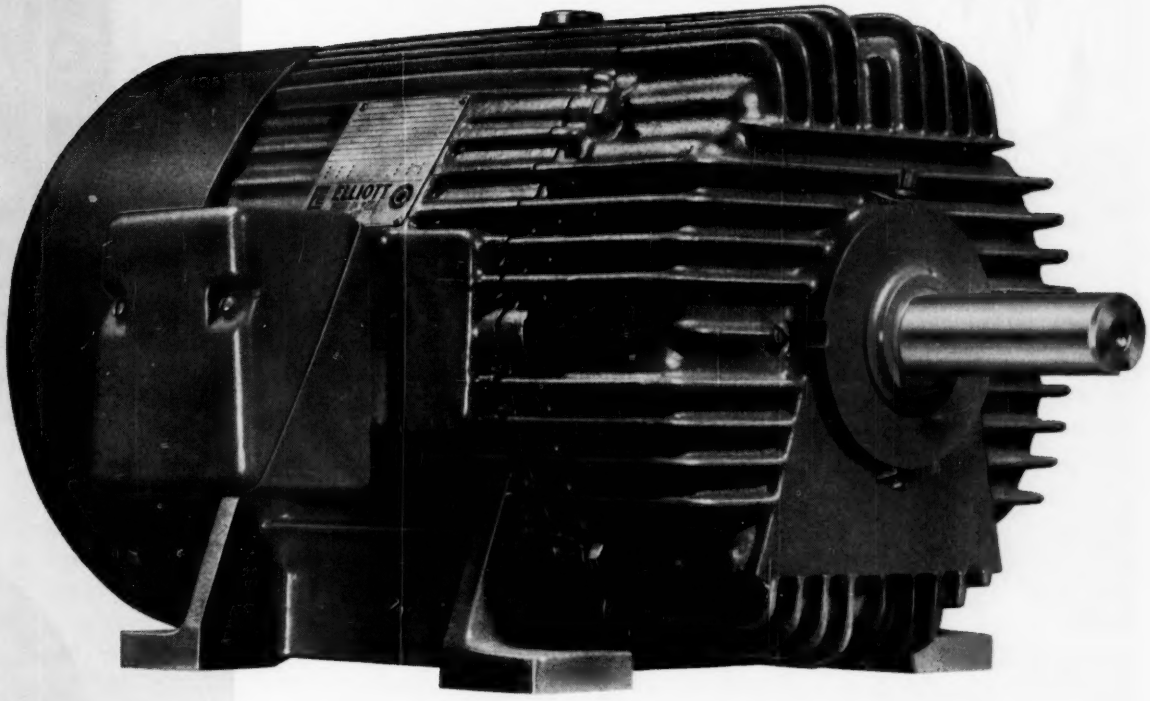
TIGHTLY COMPRESSED GROMMET seals leads where they leave motor frame. Grommet is compressed around numbered leads by pressure ring. No leakage here.



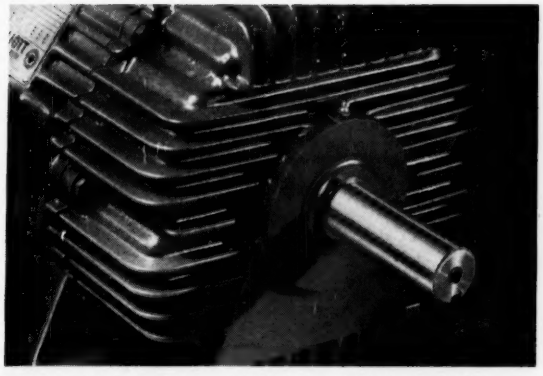
ROTATING SLINGER BANISHES MOISTURE, DIRT that otherwise might creep along shaft and through bearing. Recessed into bracket, it provides long labyrinth-type seal.

IMPORTANT FACTS
about enclosed motors are given in new Elliott Bulletin PB-6000-2. Send for free copy today.

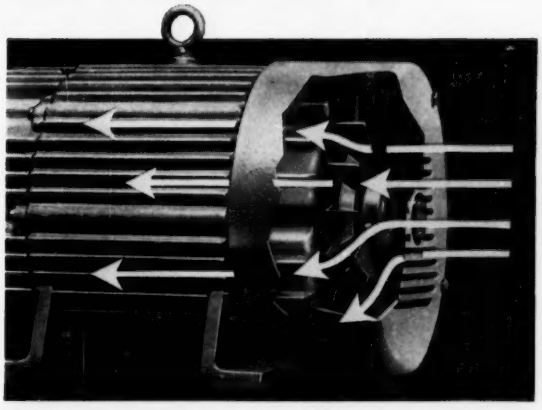
Elliott C-W ribbed-frame enclosed motors, pioneered in the United States by Crocker-Wheeler, include ratings up to 300 hp.



dependable!



MORE AND DEEPER HEAT-RADIATING FINS have greater cooling area. Generous fins over rear bracket keep bearing cool. Non-clogging, easy to clean.

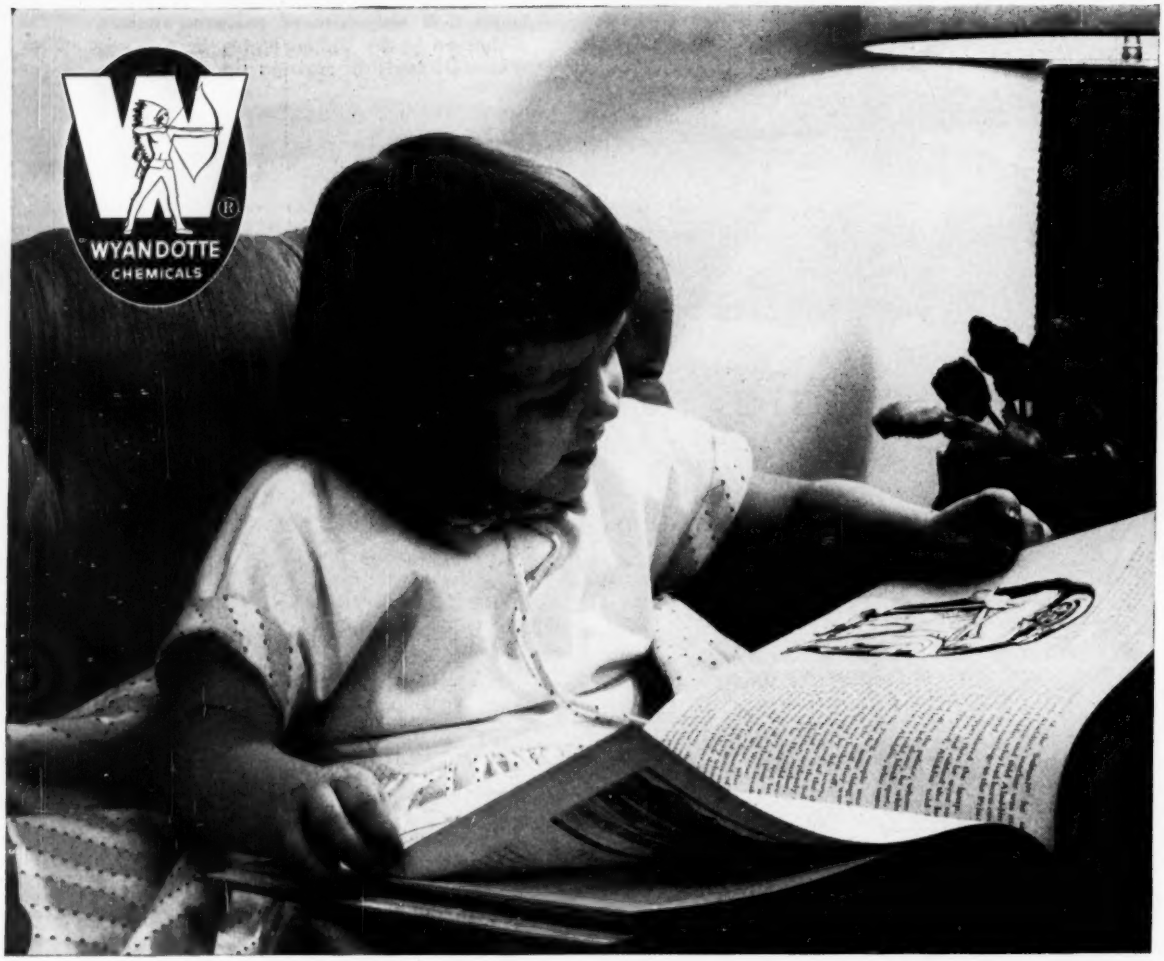


COOLING AIR BLAST FROM EXTERNAL FAN, directed by fan cowl, hugs entire length of motor. Non-sparking fan has keyed and clamped split hub.

ELLIOTT Company

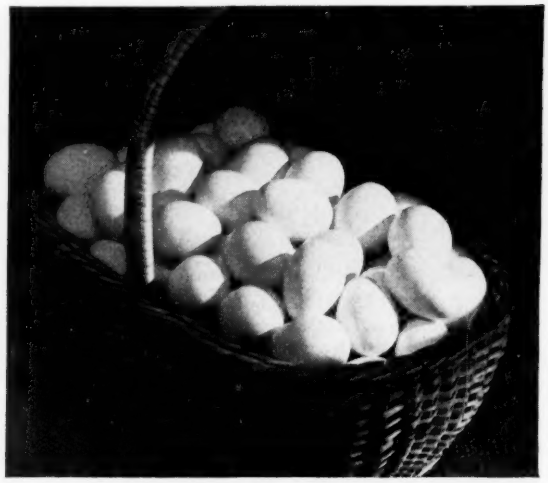
CROCKER-WHEELER PLANT • JEANNETTE, PA.

W9-1



Picture-books with the prettiest pictures are printed on stock containing Wyandotte PURECAL in the coating. Particle size, shape, purity and whiteness combine to produce a smooth, clean surface that's best for printing . . . and easy on the eyes.

Rubber gloves fit like a second skin with PURECAL in the formulation, because PURECAL improves important physical properties in non-black goods.



The best-fed hens lay better eggs . . . and PURECAL provides a prime source of calcium enrichment in poultry feed formulations, because it's so pure.

ONE OF A SERIES

WYANDOTTE PURECAL®

makes countless things better because it's so pure, so white, so uniform

Every so often you'll see a picture of ice cream or candy or cereal in a magazine and say, "That looks good enough to eat!"

If the coated stock the picture was printed on contained Wyandotte PURECAL, it literally was, at some stage, fit to eat.

You see, Wyandotte's double refining – a unique reaction process – yields precipitated calcium carbonate that exceeds U.S.P. purity standards. That's why PURECAL is the whitest material in its class . . . why it not only improves paper, but makes countless things better, from candy and cosmetics to printing inks, paints, and plastics.

PURECAL calcium carbonate is free from grit, has cubically shaped particles of accurate size . . . important advantages if your formulation calls for calcium carbonate. Samples and data are available for the writing. Because PURECAL comes in various grades for specific applications, please include details on your requirements. *Wyandotte Chemicals Corporation, Department 9-E, Wyandotte, Michigan. Offices in principal cities.*

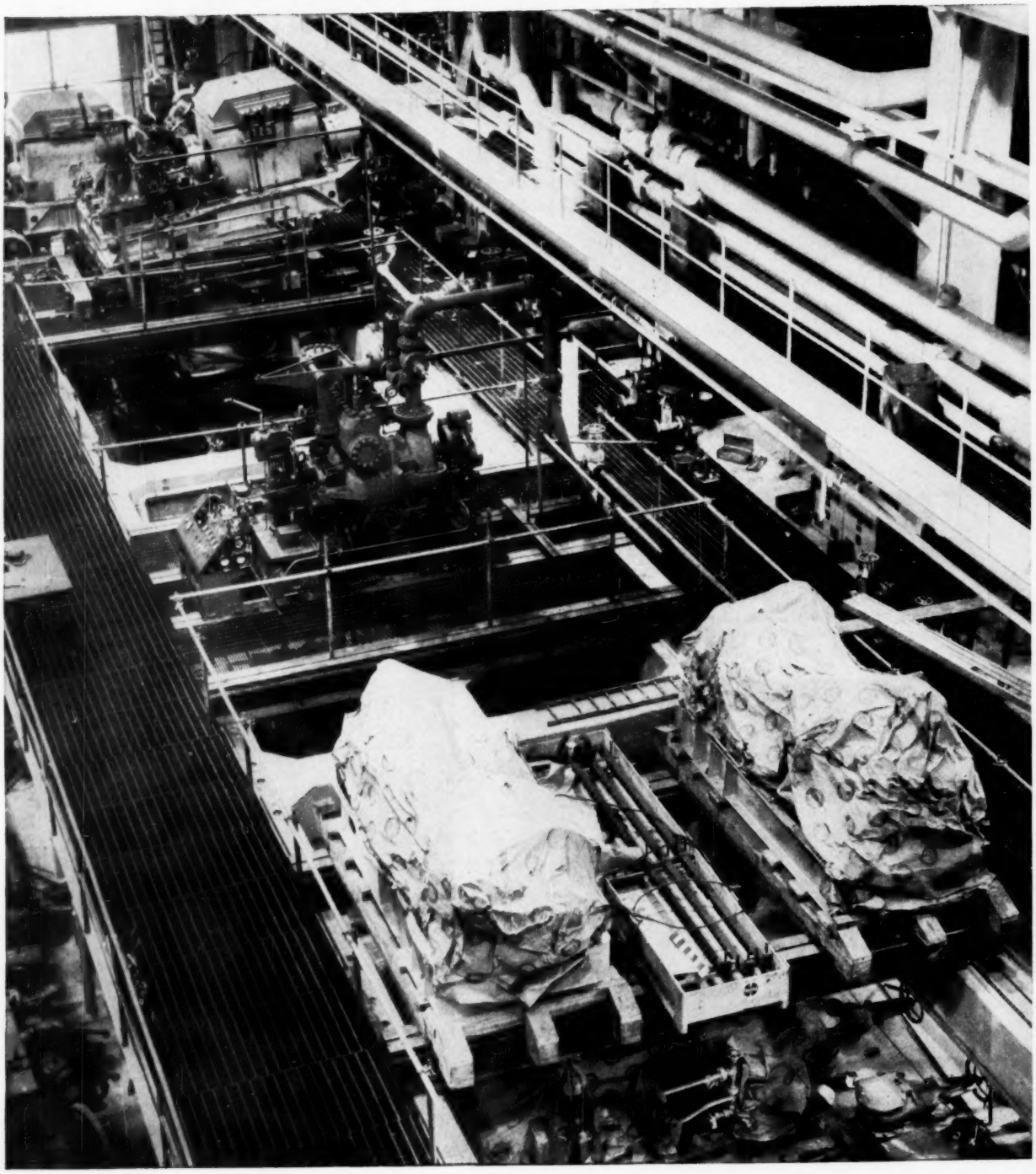
Wyandotte CHEMICALS MICHIGAN ALKALI DIVISION
PACING PROGRESS WITH CREATIVE CHEMISTRY

SODA ASH • CAUSTIC SODA • BICARBONATE OF SODA • CALCIUM CARBONATE • CALCIUM CHLORIDE • CHLORINE • MURIATIC ACID • HYDROGEN • DRY ICE • GLYCOLS
SYNTHETIC DETERGENTS (anionic and nonionic) • SODIUM CMC • ETHYLENE OXIDE • ETHYLENE DICHLORIDE • POLYETHYLENE GLYCOL • PROPYLENE OXIDE
PROPYLENE DICHLORIDE • POLYPROPYLENE GLYCOL • DICHLORODIMETHYLHYDANTOIN • CHLORINATED SOLVENTS • OTHER ORGANIC AND INORGANIC CHEMICALS

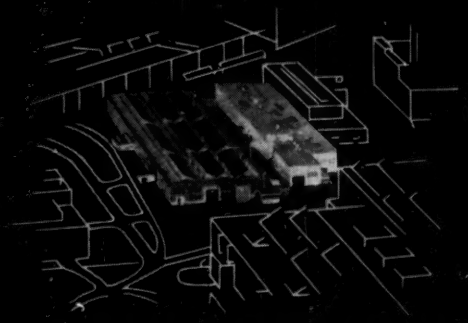
In its use as a filler or pigment in creams, ointments and skin preparations . . . PURECAL helps make the fair sex fairer. Advantage: it's grit-free.

Better bows at lower cost are produced when PURECAL is used to extend resins in glass-fiber-reinforced plastics. General use level: 30 parts per 100.

New Small Turbine Plant at Westinghouse . . .



meets your exact power needs ... speeds deliveries



As part of the Westinghouse Steam Division, these completely self-contained small turbine facilities assure you of personal attention and service.

Left: Portion of the test facilities at new plant, showing (top to bottom) tilt test, boiler feed pump test and two units ready for shipment.

Here at the world's most modern small turbine facility, engineering, manufacturing and quality control are tailored to individual customer requirements.

Backed by extensive research and development, long-range planning and expansion of these facilities now bring you these major advantages . . .

*Exact power needs from the most complete product line in the industry** — Knowing that turbine users must consider both capacity needed and the economics of steam consumption, Westinghouse has developed the world's broadest line of small turbines.

Extensive quality control — Each turbine is thoroughly tested and proved before shipment to insure the highest efficiency and reliability. Checks are made at all critical stages of production by the most advanced testing equipment available.

Individual service and fast delivery — In these new small turbine facilities, entire production sections are devoted to single components, while new assembly aisle test stands offer the most advanced production techniques available for this type of manufacturing process.

While the specialized operations of the Small Turbine Department are completely self-contained to assure you of personal attention and service, the resources, facilities and experience of the entire Steam Division are available to insure technical precision in meeting your specifications.

Westinghouse small turbine representatives will be glad to discuss your needs with you at any time. Just call, write or wire your nearest Westinghouse Apparatus Sales Office or the Westinghouse Electric Corporation, Small Turbine Sales, Lester Branch Post Office, Philadelphia 13, Pa.

**Single-Stage Turbines — seven frame sizes available with horsepowers from 5 to 4000, speeds from 1000 to 12,500 rpm, for pumps, fans, compressors, blowers, paper machines and special Navy-designed pumps.*

Multi-Stage Turbines — five frame sizes available with speeds to 16,000 rpm and horsepowers to 50,000 for paper machine drives; power plant generation up to 5000 kw; high-speed special process compressor drives; boiler feed pump drives, operating under any heat balance cycle; turbine-generator units for shipboard service.

High-Speed Reduction Gears — twelve frames are available for most economical turbine speed selection in low-speed applications.

J-50602

YOU CAN BE SURE...IF IT'S

Westinghouse

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Division of Union Carbide Corporation • 30 East 42nd Street, New York 17, N. Y.
Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. IN CANADA: Union Carbide Canada Limited, Toronto

National Carbon representatives expand your engineering force

D. S. GLASS—SALES ENGINEER

Mr. Glass graduated from Illinois University with a B.S. Degree in Chemical Engineering. For three and one-half years, he worked in the midwest as a process engineer with a petroleum additive manufacturer.

He has been with National Carbon Company since 1953. He has worked on the development and design of chemical process equipment, prepared technical design proposals and worked directly with users on the installation of carbon, graphite and "Karbate" impervious graphite equipment. Since late 1958, he has been a field engineer covering the northeastern states.

Long, Dependable Service provided by "Karbate" Process Equipment

Two 700 sq. ft. "Karbate" condensers, three "Karbate" pumps Model A and several 2" size "Karbate" valves have been used continuously since 1952 in steam distillation of a xylene and dilute hydrochloric acid mixture.

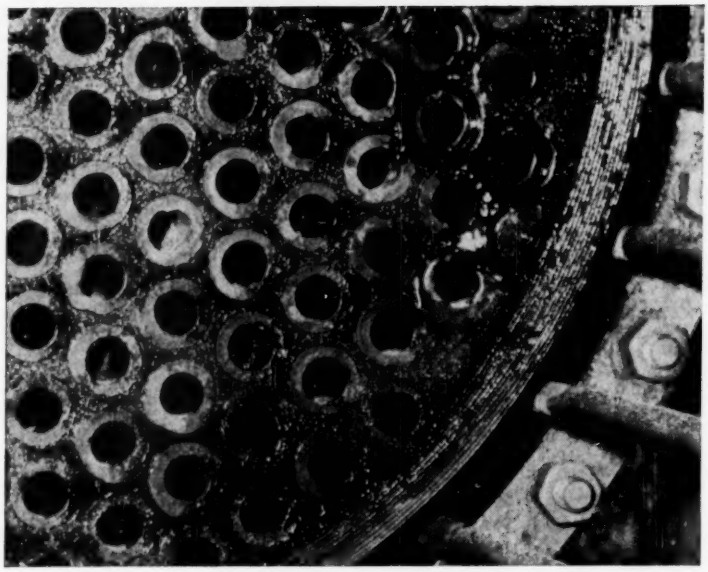
Records show the condensers have operated without maintenance since installation. In addition, a recent consideration to convert "Karbate" Model A pumps to the present standard Type C Model CA pumps could not be justified because of the excellent service records provided by the installed pumps.

NATIONAL TRADE-MARK

"National", "Karbate", "N" and Shield Device and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

UNION CARBIDE

"KARBATE" REBOILERS OPERATE 12 YEARS WITH LOW MAINTENANCE COSTS



Tube sheet of a reboiler in service twelve years. Some replacement tubes are shown. Most tubes are original ones installed in 1946. Machining marks made in 1946 are visible on the impervious graphite tube sheet.

"Karbate" impervious graphite shell and tube heat exchangers provide economic service life as reboilers handling 45-55% sulfuric acid-organic solution. Sixteen of these reboilers were installed by a major chemical company in 1946.

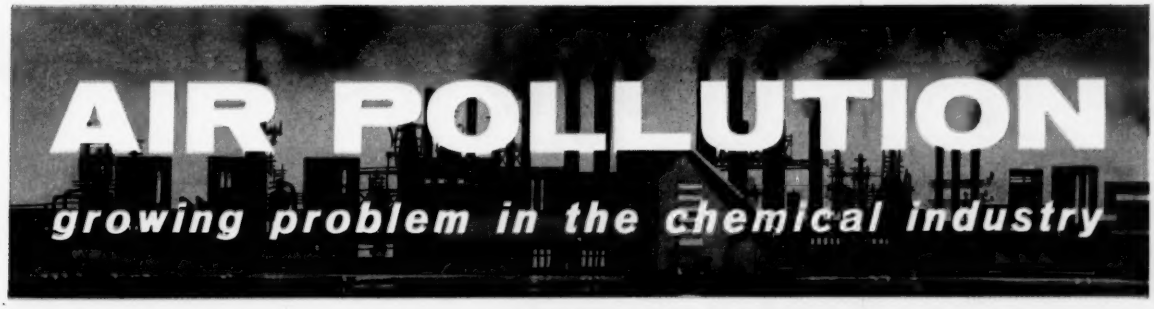
The sulfuric acid flowing through the tubes of the reboilers contained contaminants. Eventually, stubborn carbonaceous deposits formed inside the "Karbate" impervious graphite tubes and had to be removed periodically. This was done mechanically by drilling and sandblasting techniques.

	1950-1953	1954-1957
REBOILERS CLEANED (per year)	20	2
REBOILERS REPAIRED (per year)	23	9

To check performance of these units, records were kept starting in 1950 covering both cleaning and repairs.

The drop in both cleaning and repairs after 1953 is related to a modification in the process which substantially reduced carbon deposition on the tubes. The average cost of maintenance, including parts and labor for repairs and cleaning over the twelve year period, has been less than $500 per exchanger per year.

The user feels this cost is economic considering the inherent difficulties associated with this application. In other processes in this plant, "Karbate" impervious graphite exchangers which were installed approximately ten years ago are still operating without any maintenance. These units are handling corrosive chemicals at 140°F and 25 psig. pressure.



Chemico Gas Scrubbers in 415 Installations Provide 90-99.95% Removal Efficiency

"It is unpleasant at best, and can be fatal," is the sum-up by at least one expert about air pollution. The question generally posed is simply, "What can be done about it?"

The chemical processing industry *is* doing something about it. Chemico Venturi gas scrubbers have already been installed for a variety of chemical processes. One reason: the extreme adaptability of this equipment.

ADAPTABILITY PAYS DIVIDENDS FOR MOST PROCESSES

Depending on local conditions, regulations and operating requirements, Chemico equipment can be tailored to solve a wide variety of pollution control problems. Initial installation can be designed to meet minimum needs. If experience or changing conditions call for increased efficiency, this can be achieved to almost any degree with original equipment by merely increasing the power input. Where power costs are a factor, this flexibility feature of Chemico scrubbers is an important advantage.

SIMPLE CONSTRUCTION SAVES MAINTENANCE COSTS

Design simplicity of Chemico Venturi gas scrubbers means that it is possible to utilize materials resistant to corrosion, abrasion or high temperature. This, plus the fact that no critical controls are necessary, holds maintenance costs to the barest minimum. In addition, the small space requirements and complete flexibility of arrangement of Chemico Venturi scrubbers permit installation in existing plants where space is at a premium.

TYPICAL INSTALLATIONS

IRON & STEEL INDUSTRY —
Gray Iron Cupola; Oxygen Steel Converter; Steel Open Hearth Furnace (Scrap); Steel Open Hearth Furnace (Oxygen Lanced); Blast Furnace (Iron); Electric Furnace; Rotary Kiln-Iron Reduction; Crushing & Screening.

CHEMICAL INDUSTRY —
Acid-Humidified SO_3 (a) Scrub with Water (b) Scrub with 40% Acid; Acid Concentrator; Copperas Roasting Kiln; Chlorosulfonic Acid Plant; Dry Ice Plant; Wood Distillation Plant; $TiCl_4$ Plant, TiO_2 Dryer; Spray Dryers; Flash Dryer; Potassium Phosphate; Chemical Incinerator.

NON-FERROUS METALS INDUSTRY —
Blast Furnace (Sec. Lead); Reverberatory Lead Furnace; Ajax Furnace-Magnesium Alloy; Zinc Sintering; Reverberatory Brass Furnace.

MINERAL PRODUCTS INDUSTRY —
Lime Kiln; Asphalt Stone Dryer; Cement Kiln; Dolomite Kiln; Magnesia Kiln.

PETROLEUM INDUSTRY —
Catalytic Reformer; Acid Concentrator; TCC Catalyst Regenerator.

FERTILIZER INDUSTRY —
Fertilizer Dryer; Superphosphate Den & Mixer.

PULP & PAPER INDUSTRY —
Lime Kiln; Black Liquor Recovery Boiler.

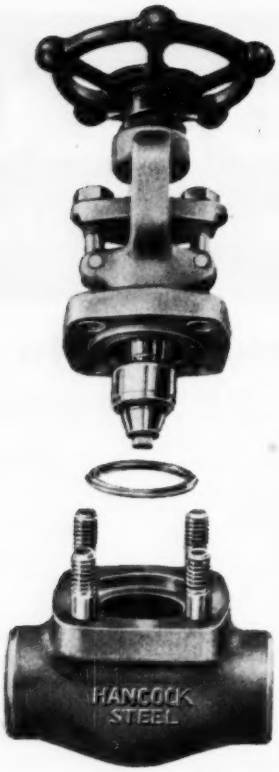
MISCELLANEOUS —
Pickling Tanks; Boiler Flue Gas; Sodium Disposal Incinerator.

FULL DETAILS AVAILABLE—For your copy of a new brochure giving complete data on Chemico Venturi gas scrubbers or for technical assistance on a specific problem, write to the address below.

CHEMICO

CHEMICAL CONSTRUCTION CORPORATION
525 West 43rd Street, New York 36, New York

CHICAGO • DALLAS • HOUSTON • PORTLAND, ORE. • TORONTO • LONDON • PARIS • JOHANNESBURG • TOKYO



NEW VALVE-OLOGY

shuts off costly maintenance

Hancock 600# Steel Valves incorporate new concepts in valve-ology that reduce valve maintenance and equipment down-time. The forged steel bonnet and body have butting flanges so strong no distortion is possible. The flanges form a bonnet joint that utilizes the sealing power of a Flexitallic* gasket so effectively not even pressures exceeding ten times the rating of the valve can cause a blowout.

Hancock valve-ology makes full use of stainless steel to reduce your valving cost. Seat, disc, stem, swing bolts and nuts, thread bushing, packing gland follower—all are stainless steel. Globe, Angle, "Flocontrol", Lift Check, and Hi-Pressure Drop designs available. A high degree of standardization simplifies servicing and inventory needs. Your industrial supply distributor will gladly give you full details on Hancock Valve quality and performance. Phone him today.

Hancock 600# Steel Globe Valve. Type 5500 Line. Sizes: ¼" thru 2".

*Trademark of Flexitallic Gasket Company

HANCOCK STEEL VALVES

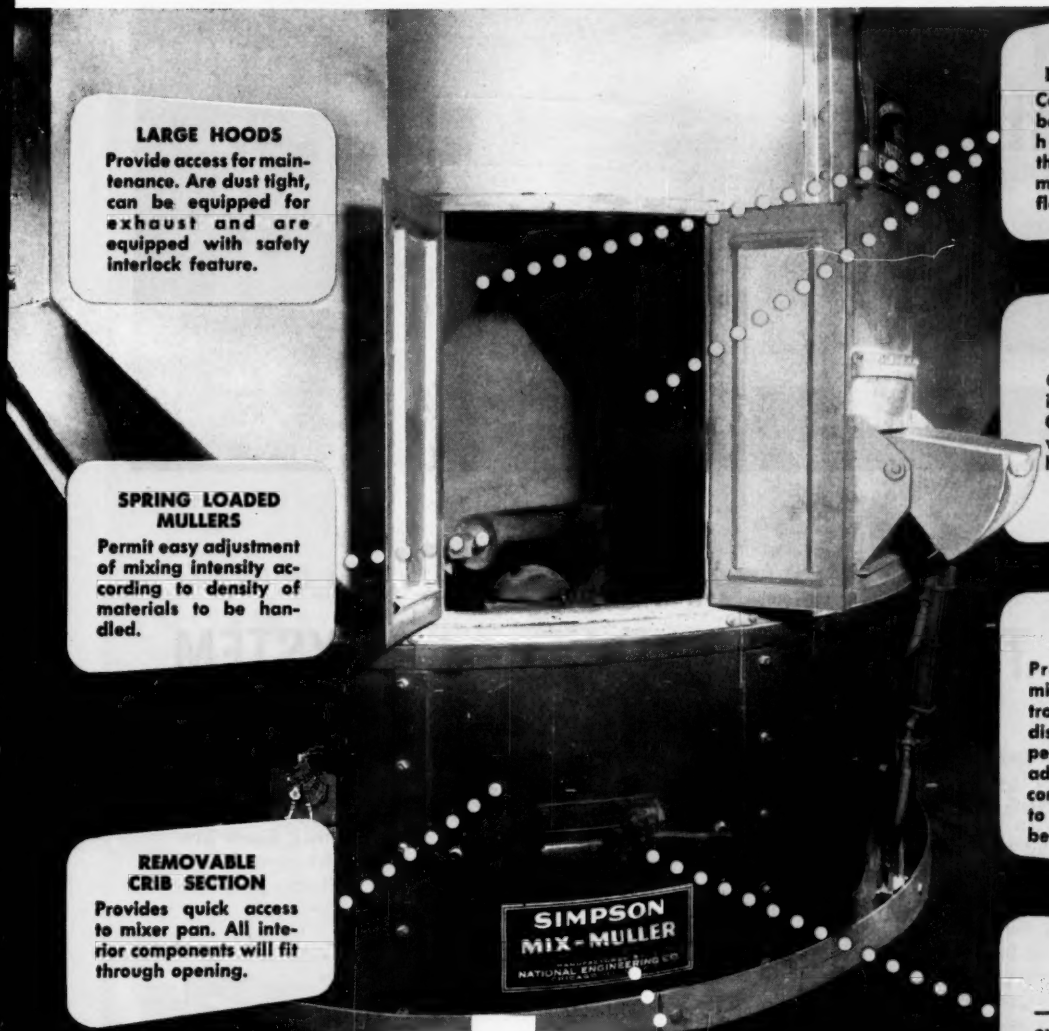
A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Watertown, Massachusetts

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

Why Engineers prefer Simpson *MIX-MULLER*®



LARGE HOODS
Provide access for maintenance. Are dust tight, can be equipped for exhaust and are equipped with safety interlock feature.

SPRING LOADED MULLERS
Permit easy adjustment of mixing intensity according to density of materials to be handled.

REMOVABLE CRIB SECTION
Provides quick access to mixer pan. All interior components will fit through opening.

BOTTOM DISCHARGE
Plows clear pan quickly, thoroughly—*automatically* through bottom door. Discharge to belt, elevator, hopper screen, etc., is easily arranged.

HOOD CAN ENCLOSE HOPPERS
Components of mix can be held ready in batch hoppers. You get the *quality* of a batch mix, on a continuous-flow basis.

ADDITIONS HOPPER
Can be air or mechanically operated.
Can be located anywhere on periphery of hood.

TIME MASTER® CONTROLS
Provide push button mixing operation. Control of mixer charge, discharge, batch hoppers, water and other additions as well as control of material flow to and from mixer, can be automatic.

MATERIAL SAMPLER
—is safe, positive and externally mounted at position of users choice.

THE SERVICES OF NATIONAL

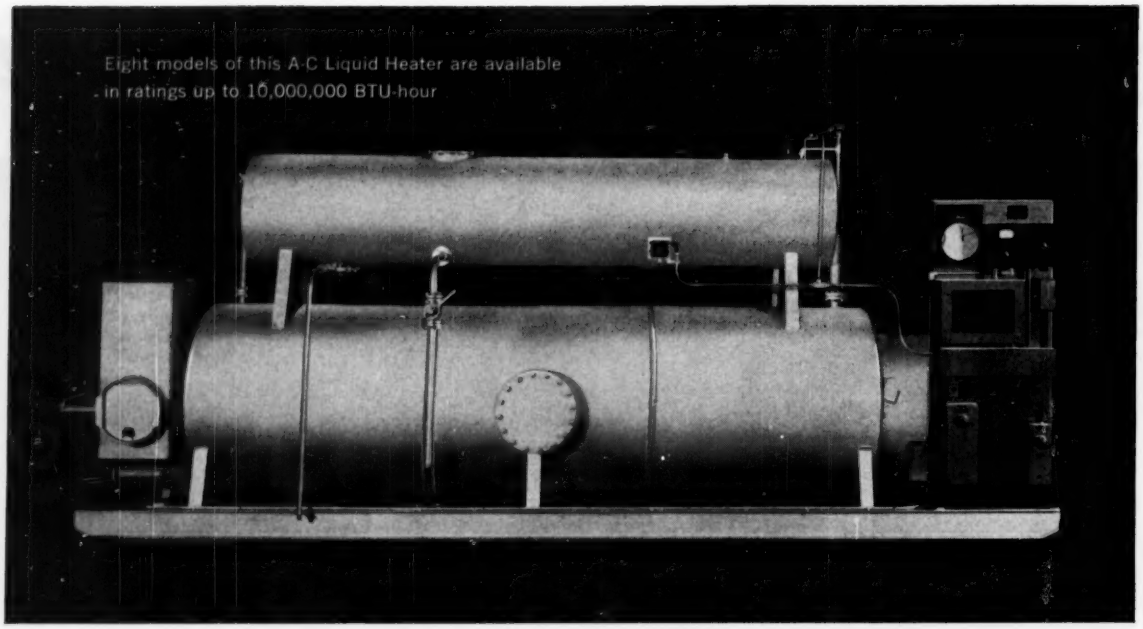
. . . Engineering Company stand behind every Simpson Mix-Muller produced. By taking advantage of these services you get the benefit of 40 years of practical experience in the integration of mixing equipment. Complete design and engineering facilities for materials handling equipment, raw materials storage, etc., are included in the National service. This single responsibility through design, manufacture and installation will assure you of top mixing performance . . . from a properly integrated mixing plant.

Write for the new bulletin on mulling.

SIMPSON MIX-MULLER® DIVISION

National Engineering Company
636 Machinery Hall Building • Chicago, Illinois

C576



Need Automatic, Accurate, Indirect Process Heat Up To 650° F?

CHECK THIS NEW LIQUID HEATING SYSTEM

This new Allis-Chalmers Liquid Heater *operates at atmospheric pressure.* It is thoroughly stable and fully automatic. It generates and delivers heat up to 650°F with safety and economy. In any process requiring accurately-controlled heat, the A-C Liquid Heater gives you these advantages:

Increases Your Output – Applied to existing equipment, this low-pressure system can deliver higher processing temperatures that increase production and lower costs. On new construction, its flexibility eliminates the need for auxiliary equipment, permits simplified design without high-pressure code vessels, cuts initial cost.

Close, Automatic Temperature Control – The temperature of the heat transfer medium in the A-C Liquid Heater is independently controlled. Thus the heated liquid is *always* at a predetermined temperature.

Completely Safe – A-C Liquid Heaters are thermally stable, will not air-lock, vapor-bind or flood. Explosion hazards are eliminated.

Economical to Install, Operate – Initial installation cost is usually less than one cent per BTU per hour of gross heat load on most units. There are no complicated start-up or shut-down procedures; system operates automatically with only monitoring of instruments required.

For bulletins containing complete information on this new Liquid Heating System, contact your nearest Allis-Chalmers office, or write Allis-Chalmers Manufacturing Co., Hydraulic Division, York, Pa.

Hydraulic Division RESEARCH DESIGN HYDRODYNAMICS ENGINEERING FABRICATION

Hydraulic Turbines & Accessories • Pumps • Liquid Heaters
Rotovalves • Ball Valves • Butterfly Valves • Free-Discharge Valves

ALLIS-CHALMERS

NOW
FOR LESS ODOR,
CLEANER EVAPORATION
NEW IMPROVED

VARSOL®

For the latest quality improvements in mineral spirits, you can count on *new* Varsol. This top-grade Esso solvent is specially tailored by *new* refining techniques and finished to *new* levels of odor and volatility. Here is a real change in your raw material availability picture: an old standby — Varsol — now better than ever! For technical assistance with your solvents problems, contact your nearest Esso Standard Oil Company office, or write Esso Standard Oil Company, Solvents Division, 15 West 51st Street, New York 19, New York.

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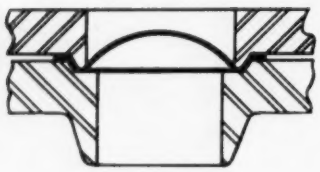
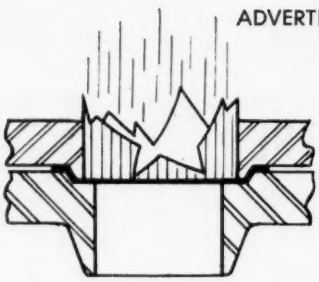
PETROLEUM SOLVENTS

A COMPLETE FAMILY OF AROMATIC SOLVENTS FOR ALL OF INDUSTRY'S REQUIREMENTS
SOLVESSO 100 • SOLVESSO 150 • SOLVESSO TOLUOL • SOLVESSO XYLOL

ADVERTISEMENT



The BS&B Safety Head provides a leak-tight assembly under normal operating conditions.



When pressure reaches the rated rupture point of the disc, instant release is provided through full orifice diameter by the outward bursting of the rupture disc.

For Chemical And Design Engineers...

An Advanced Approach To Pressure Release Or Transfer

Although BS&B Safety Heads have been employed for over-pressure protection in closed pressure systems in numerous industries for more than 25 years, it is only recently that they have come into their own as a pressure *transfer* device.

Recent metallurgical and engineering developments, as well as improved manufacturing procedures, have made the BS&B Safety Head the lightest weight, most accurately calibrated pressure release device ever developed. A typical Safety Head consists of a metal rupture membrane secured in mounting flanges. There are no moving parts.

How It Functions

The rupture membrane, or disc, is a purposely designed "weak spot" in the pressure chamber or system. When the internal pressure rises to the rated rupture point of the disc, the disc bursts to provide an instantaneous full-throated relief opening.

This outstanding feature is most advantageous when applied to pressured systems where ignition or exothermic reaction during a given process causes abnormal pressure rise in seconds or milliseconds.

Well Suited To Processing Applications

The application and design of Safety Heads is continually being expanded. They have found wide use in such diversified fields as Food and Chemical Processing, Aircraft and Missile Propulsion, Oil and Gas Production and Processing, Air Conditioning and Refrigeration, Electrical Power Generation and many others.

As an example . . . visualize the rupture disc as a seal to retain a fluid under pressure within a chamber until a given critical pressure had been reached, or until actuated (burst) by a surge of pressure developed within seconds or milliseconds. The pressurized fluid is thus discharged into another chamber where contact with another component in the process will result in ignition, or in a desired chemical reaction.

As a different application of the same basic device, the rupture disc could serve as a signalling device . . . or to retain pressure to a pre-determined point whereupon it would then be actuated by an explosive squib or primacord.

If acids, caustic or other corrosives are present in the process, BS&B Safety Head rupture discs may be obtained with one of several impervious and/or dielectric coating materials such as Teflon, Kel-F, etc. Certain conditions can also be met through use of various metals in the rupture disc itself, such as stainless steel, aluminum, silver, platinum or special alloys.

Infinite Design Variations Possible

BS&B Safety Heads have been manufactured in sizes ranging from ⅛" to 44" in exposed diameter of the rupture disc and in pressure ratings as low as 5 psi and as high as 100,000 psi. Mounting flanges can be supplied from any suitable metal or alloy.

Uses Limited Only By Your Imagination

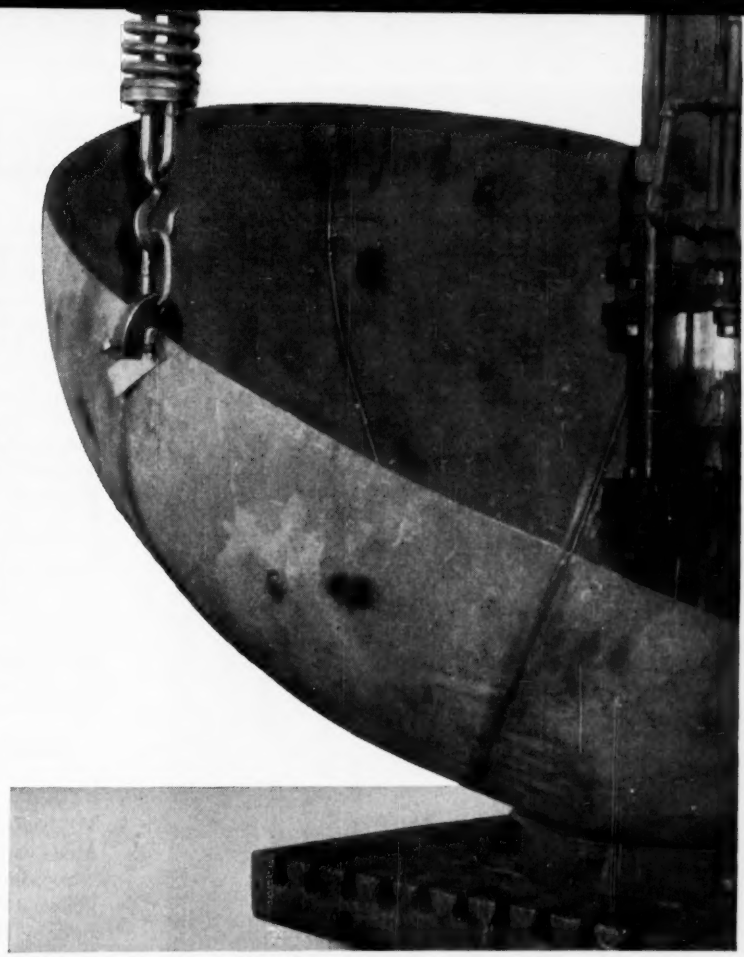
New and unusual pressure relief requirements involving corrosives, elevated or sub-zero temperatures, pulsating pressures, alternate pressure and vacuum, pressure cycling, or even low to high pressure shock are constantly being solved by the BS&B Safety Head.

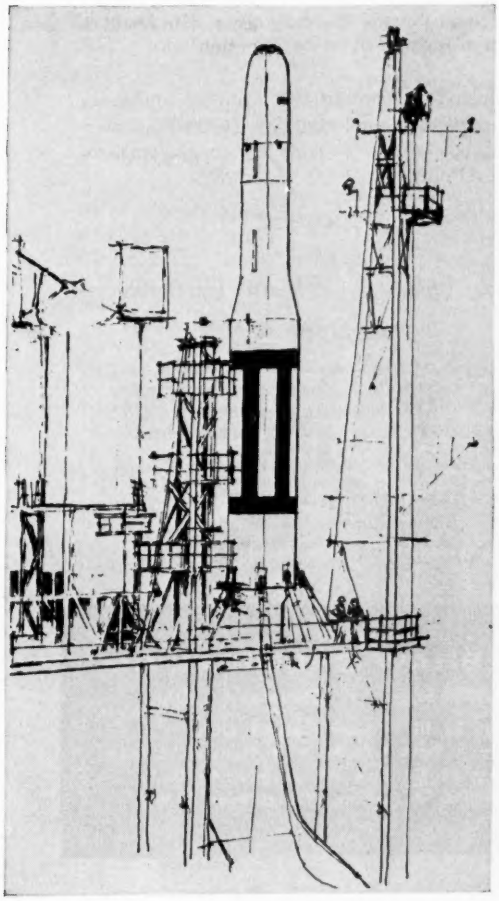
If you need overpressure protection or have a pressure transfer requirement calling for a device that will provide instantaneous pressure release, be sure to consider the BS&B Safety Head. It may very well be your answer. Contact your nearest BS&B sales office or agent, or the Safety Head Division Headquarters in Kansas City.

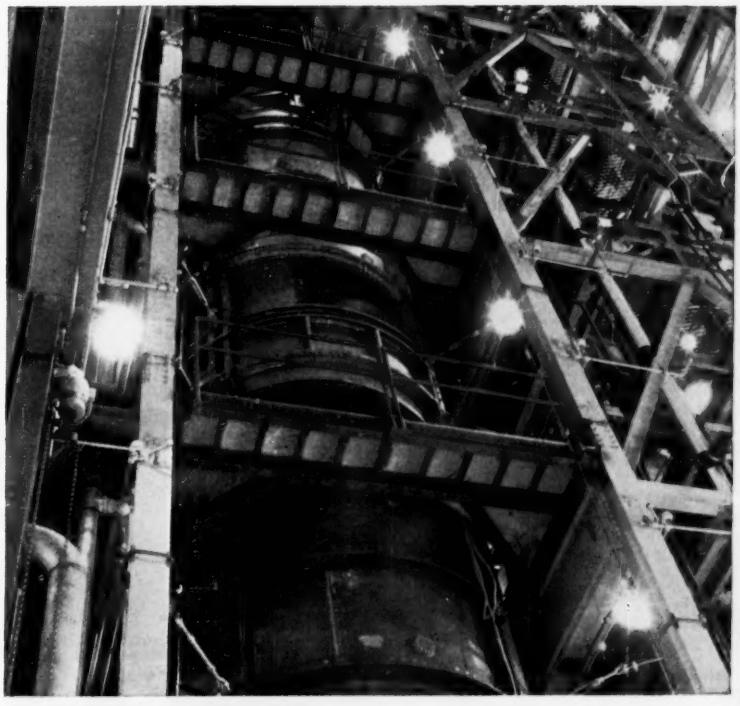
BLACK, SIVALLS & BRYSON, INC., Safety Head Division, Dept. **2-N3A**
7500 E. 12th Street, Kansas City 26, Missouri

ONE IMPORTANT REASON WHY THERE CAN BE A BLASTOFF

The dome head you see at the right is part of what are familiarly known among the missiles people as "battleship tanks." That's because it is too heavy to be air borne. Yet it performs an important function in the missiles program. It is a part of heavy-walled units like those below which are used to test components, subsystems and systems for the TITAN missile by The Martin Company at its Denver facility. Graver's assignment was a number of dome heads and cones for this testing installation, another example of how Graver's century-proved skills with alloys and special steels are being employed in the missiles program.







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DIVISION—UNION TANK CAR COMPANY
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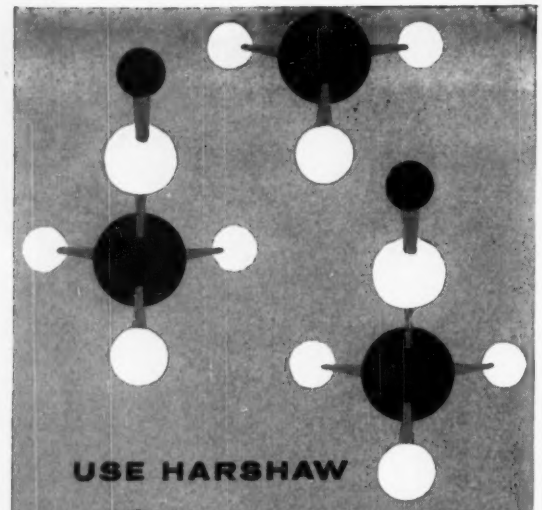
Plants and Offices Across America



USE HARSHAW

Sodium Methylate

POWDER OR LIQUID

Catalyst for use in "Rearrangement" of edible fats and oils, particularly lard, and in the manufacture of sulfa drugs, pharmaceuticals, and other organic chemical intermediates.

HARSHAW

Harshaw Sodium Methylate Powder

(Spec. 101)

Packaged in air tight steel drums of 10, 25, 50 and 200 pounds net.

Free Flowing white hygroscopic powder
Formula $NaOCH_3$
Sensitive to air and moisture
Packs 4.2 pounds per gallon
Formula Weight 54.03

CHEMICAL ANALYSIS

Sodium Methylate	97.5%
Sodium Hydroxide	0.5
Sodium Carbonate	0.4
Sodium Formate	0.3
Methanol (Free)	0.5

Soluble in Alcohols, Fats, and Esters
Decomposed violently by water
Standard 95.0% min.

PHYSICAL PROPERTIES

Fine white powder—over 75% through 150 mesh—less than 1% on 10 mesh

Melting Point: none . . . decomposes in air above 260°F.

Harshaw Sodium Methylate Liquid

(Spec. 102)

Packaged in Steel Drums . . . . 425 pounds net
25% solution of sodium methylate in methanol

Analysis:

Sodium Methylate Content . . 25% minimum

Physical Properties: slightly cloudy to clear solution

Bulking Density . . . . . about 7 lbs. per gallon
Initial Boiling Point . . . 188°F for 25%
Flash Point (Cleveland Open Cup) . 85-90°F
Flash Point (Closed Cup) . . . . . 80°F
Crystallization Temp. . . 30°F after equilibrium

STABILITY

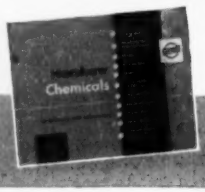
Harshaw sodium methylate, both in powder and solution form, is stable in the sealed containers. Exposure to air will cause progressive decomposition—rapidly for the powder, more slowly for the solution.

Harshaw warehouses are geographically located and amply stocked to ship your orders without delay. If you have a problem our technical service men will work with you toward its solution.

Contact Harshaw for more information.
Please call or write today.

FREE! This 16-page booklet lists the many chemicals available from Harshaw.

WRITE TODAY FOR YOUR COPY



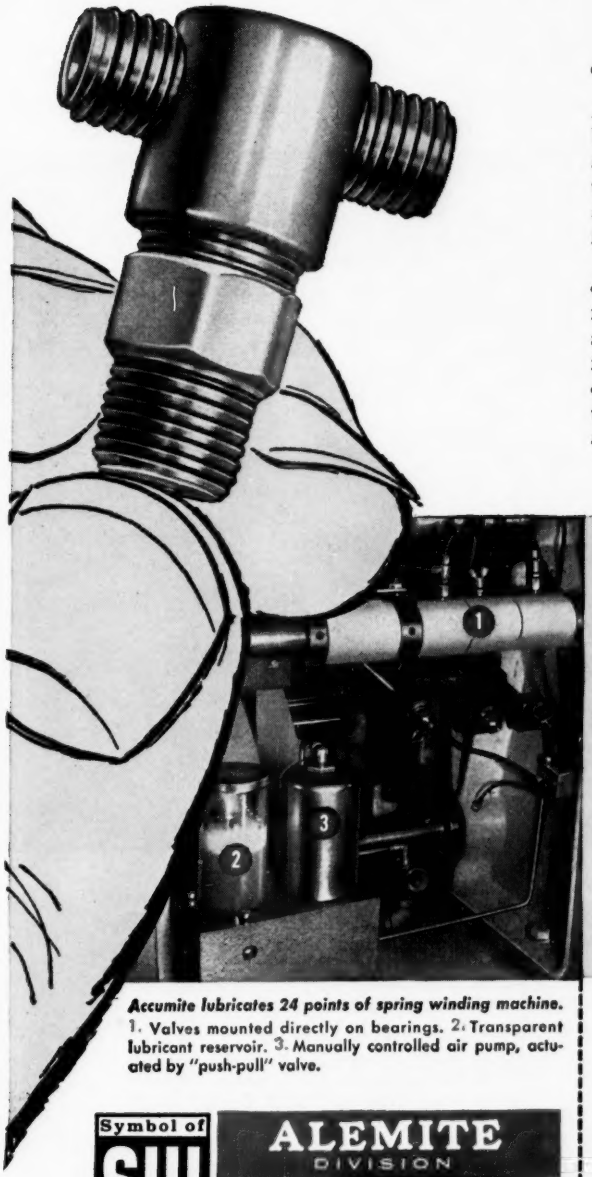
THE HARSHAW CHEMICAL CO.

1945 East 97th Street • Cleveland 6, Ohio

Chicago 32, Ill. • Cincinnati 13, Ohio
Cleveland 6, Ohio • Detroit 28, Mich. • Houston 11, Texas
Los Angeles 22, Calif. • Philadelphia 48, Pa.
Pittsburgh 22, Pa. • Hastings-On-Hudson 6, N. Y.

ACCUMITE® BY ALEMITE

...TO GIVE ANY MACHINE ALL THE ADVANTAGES OF CENTRALIZED LUBRICATION...AT LOW COST!



Accumite lubricates 24 points of spring winding machine. 1. Valves mounted directly on bearings. 2. Transparent lubricant reservoir. 3. Manually controlled air pump, actuated by "push-pull" valve.

Engineered for limited space, outperforms many higher-priced systems!

Alemite—with more than 40 years of centralized lubrication experience—announces an all-new compact system complete with pump, metering valves and controls—especially designed to service many machines and vehicles where centralized lubrication has been impractical until now!

Alemite's new compact Accumite system is especially adaptable to light, precision, multiple-bearing machines that have limited installation space. Its small size and simple installation overcomes cost limitations in most plants. Typical applications are: packaging, canning, labeling and textile machines... and machine tools. It is also suitable for tractor trailers, lift trucks and farm implements.

ACCURATELY METERS THESE SHOTS OF OIL OR GREASE

.003 cu. in. .006 cu. in. .009 cu. in.

ALL THE ADVANTAGES OF "BUILT-IN" MEASURED LUBRICATION—PLUS COMPACT SIZE!

- Meters exact amounts of refinery-clean lubricants to all bearings whenever system is operated.
- Eliminates shutdown time for lubrication.
- Seals lubricant against dirt, grit and water.
- Prevents bearing troubles due to neglect or use of wrong lubricants.
- Services all bearings in one operation.
- Avoids work spoilage and bearing repairs due to over-lubrication.

Mail coupon for full information!

ALEMITE, Dept. J-39
1850 Diversey Parkway, Chicago 14, Ill.

Please send me all the facts about your new "Miniature" Accumite system.

Name_____

Company_____

Address_____

City_____ Zone____ State_____

Symbol of SW Excellence

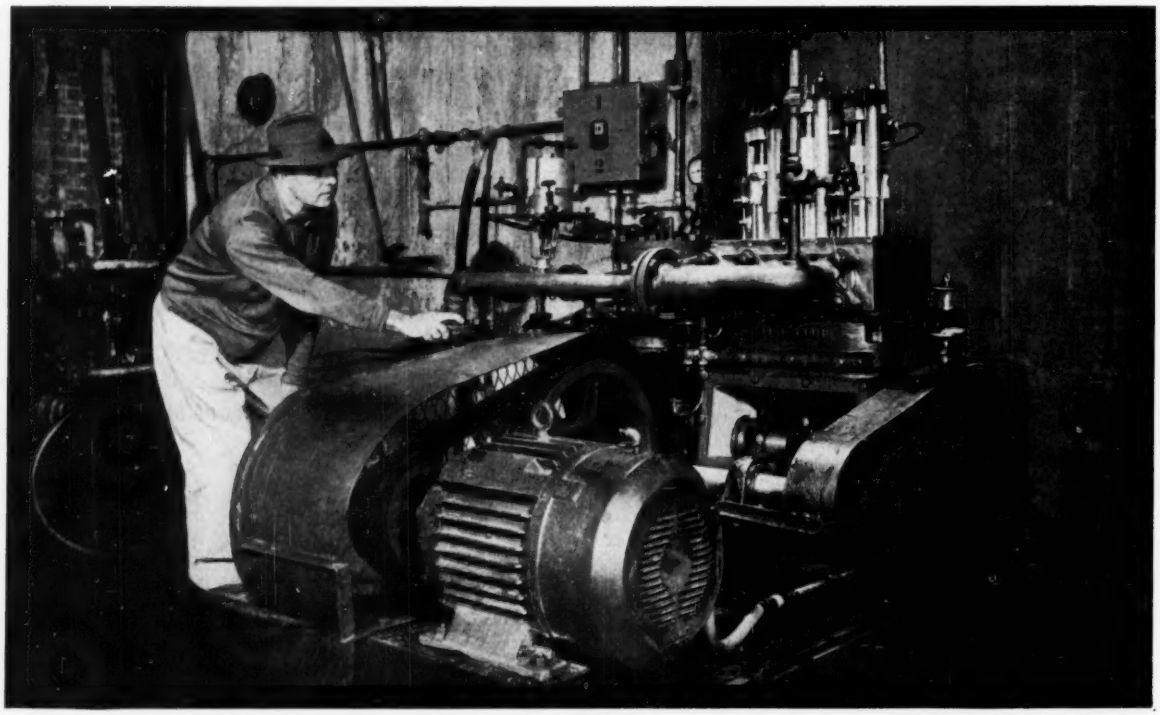
ALEMITE DIVISION
STEWART-WARNER CORPORATION

1850 Diversey Parkway, Chicago 14, Ill.

JACQUES WOLF & CO. SOLVES PROBLEM:

How to maintain constant, undeviating pressure in the production of highly corrosive chemicals

Precise, non-fluctuating pressures must be maintained in continuous processes at the Carlstadt plant of Jacques Wolf & Company. Erratic pressure caused by drop in volumetric efficiency could ruin an entire batch of costly material.

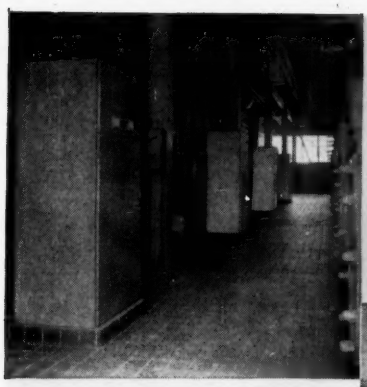


How Jacques Wolf solved the puzzle: Looking for an answer to the problem of holding constant pressure, plus that of increasing production, Jacques Wolf called on Aldrich. Aldrich engineers designed a pump which provided the proper corrosion resistance, fluid velocity and wear characteristics to insure dependable, continuous operation.

Result: After five months of use, the Aldrich Triplex Pump has met all guarantees and proven itself capable of continuous operation. Working 24 hour days, 6 day weeks, the Aldrich Triplex Pump provides the necessary pressure without fluctuation, efficiently handling both alkaline and acidic materials.

We'll be glad to send you full information on Aldrich Pumps and their advantages to you. Simply write Aldrich Pump Company, 3 Gordon Street, Allentown, Pa.

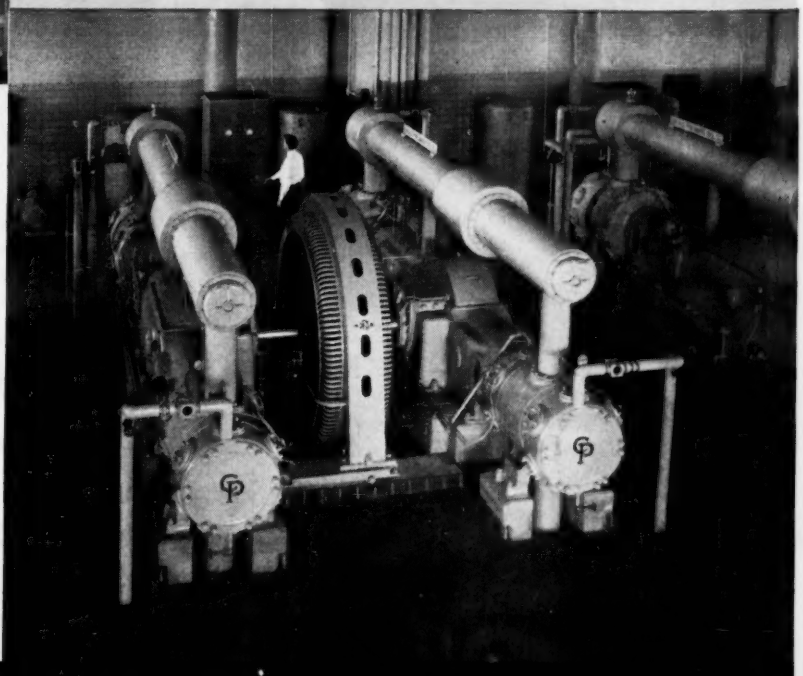
the toughest pumping problems go to ALDRICH

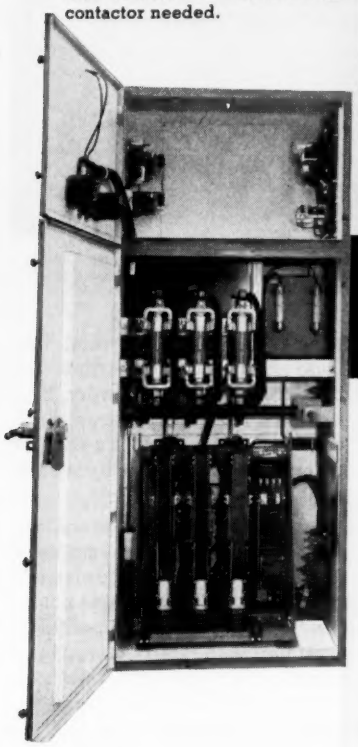


The most complete synchronous motor protection you can buy

Above and at right • Four EC&M 1000 HP, 2300 Volt Synchronous Starters on air-compressor drives in Chrysler Corporation's new Ohio Stamping Plant at Twinsburg. Purchased and installed by Hatfield Electric Co., Cleveland, Ohio.

Below • Inside view of starter showing compact arrangement of fuses and contactor. The three arc shields slide out for quick access to both front and rear contacts—no draw-out of contactor needed.





EC&M 2200-4800 VOLT STARTERS

• A push of the "start" button gives you complete protection during starting and running—*plus* EC&M *fully automatic synchronization.* Throughout the entire sequence, motor windings are completely protected and synchronization occurs at the most favorable time. Should the motor pull out of step because of voltage dip or overload, the field is automatically removed. Re-synchronization occurs when the motor re-accelerates the load. Short circuit protection is provided by current-limiting power fuses working in conjunction with EC&M's *"certified"* high-interrupting-capacity ZHA air-break contactor.

For complete details...

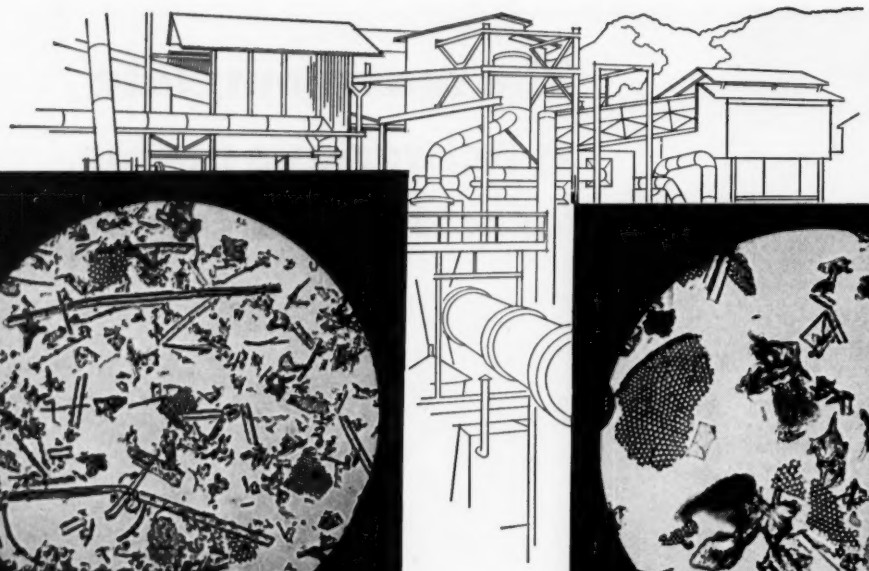
WRITE FOR BULLETIN 8210

THE ELECTRIC CONTROLLER & MFG. CO.

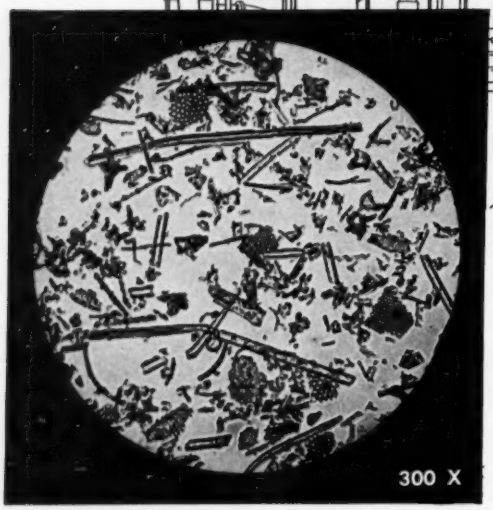
A DIVISION OF THE SQUARE D COMPANY

CLEVELAND 28 • OHIO

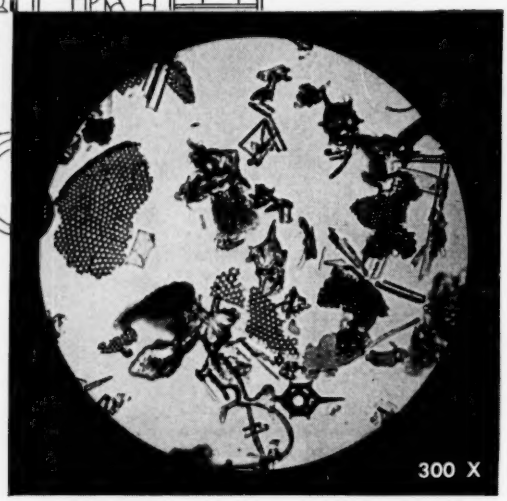
8897



Milling and calcining equipment used for all Celite grades.



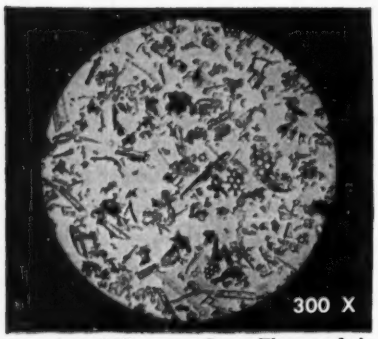
For high-clarity filtration of most liquids—use this specially milled diatomite, Hyflo Super Cel.



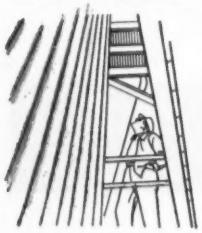
For filtration of larger suspended particles—Celite 545 combines maximum clarity plus faster flow rates.

In diatomites, Johns-Manville precision processing works for you

Constant uniformity in every grade of Celite assures consistent results, less down-time



For mineral filler use—Super Floss grade is made up of carefully sized fines air-floated off in the bag house.



Typical J-M bag house equipment.

As the microscope shows, each grade of Celite* diatomite has its own distinctive particle size distribution. Yet no matter where or when purchased, each remains uniform from bag to bag—your assurance of top production results with minimum down-time.

Three examples of flux-calcined Celites are shown here. Hyflo® Super Cel is widely used for filtration in many industries. It has just the right combination of coarse and fine particles to assure optimum clarity and flow rates. Celite 545, with a higher percentage of coarse particles, is used to achieve maximum clarity and faster flow rates with liquids that have larger suspended particles.

Super Floss, one of several bag house grades, has fine particle size distribution. A white powder, it is processed within very narrow tolerances (2-4 microns). It is a popular mineral filler in fine products such as silver polishes.

Johns-Manville can precision-produce so many different grades of Celite because it mines the material from the world's largest and purest commercially available deposit. For assistance with specific filtration or mineral filler problems, talk to a nearby Celite engineer. Or write direct to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products.

JOHNS-MANVILLE

Rockwell-Nordstrom fig. 114 valves handling molten phosphorus at 84°C. Maintenance Superintendent says, "Maintenance has been absolutely nil for 5 years."

try THIS with ordinary valves

The Rockwell-Nordstrom *lubricated* plug valves shown above are handling molten phosphorus. They've been performing perfectly for *five years;* other valves tried on this service failed in *five weeks.* Isn't it logical that a valve capable of delivering outstanding performance in the *toughest* services is also your best assurance of longer valve life and lower cost on *any* service?

In Rockwell-Nordstrom valves, positive shut-off is assured by pressurized lubricant sealing between the valve plug and the body. *Since lubricant sealing is instantly replaceable,* it can't "wear out" like ordinary metal-to-metal seats. And vital seating areas are never exposed to the line. This means real cost cutting in terms of longer valve life and far lower maintenance.

Rockwell-Nordstrom is the original and world's most complete line of lubricated plug valves. Send coupon for details or have a Rockwell field engineer visit your plant. Rockwell Manufacturing Co., Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers, Limited.

ROCKWELL-Nordstrom VALVES

another fine product by

ROCKWELL

LUBRICATION MAKES THE DIFFERENCE

Rockwell Manufacturing Company
Pittsburgh 8, Pa.

Please send free booklet V-203 ☐
Please have your sales engineer call ☐

Name_____ Title_____

Address_____

City_____ Zone_____ State_____

FLUIDICS

is a Pfaudler Permutit program providing
the know-how
the equipment
and the experience
for solving problems involving fluids.

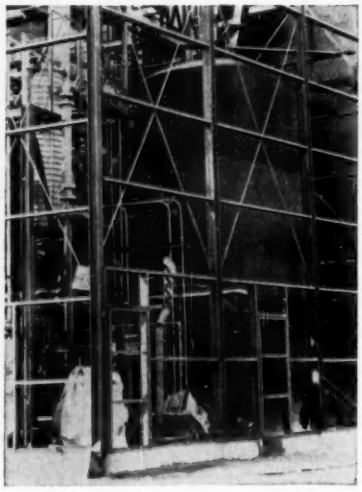
FLUIDICS covers such varied phases of fluid handling and control as:

corrosioneering
water treatment
waste treatment
reactions
polymerization
ion exchange
fluid analysis, metering and control
agitation
evaporation
distillation
drying
blending
metering
valving
flow rate control
piping
storing
centrifuging
filling
heat transfer etc.

Whenever you have a fluid-handling problem, look to this Pfaudler Permutit FLUIDICS program for the best solution.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . .
the science of fluid processes



FLUIDICS AT WORK

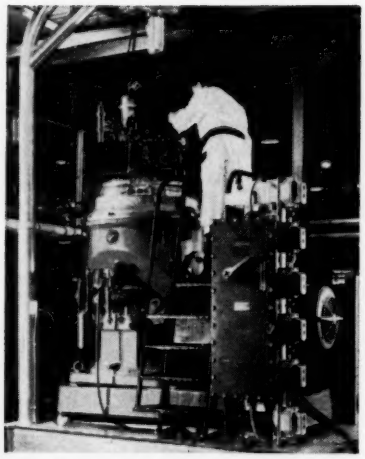
Glasteel takes the bite out of chlorine dioxide

Chlorine dioxide generation is an excellent example of the depth of our FLUIDICS program. Here is a highly corrosive material made from other corrosives in a complex process.

The chemicals commonly used have no corrosive effects whatsoever on Glasteel—sodium chlorate, sulfuric acid, and methanol in the Solvay process; sulfur dioxide, sulfuric acid, and sodium chlorate in the Olin Mathieson process.

An even more important factor here is the sheer versatility of Glasteel. You can use it wherever corrosives are present . . . everywhere from generators to storage tanks to pumps to pipes, fittings, and valves.

More than 25 pulp and paper mills are now using Glasteel equipment from Pfaudler for chlorine dioxide generating processes. And, when they do a complete cost analysis covering original prices, maintenance costs and long range equipment life, they find Glasteel the most economical equipment they can use.



FLUIDICS AT WORK

Now, a packaged centrifuge for in-plant production line testing

So that you can test our Titan centrifuge with your own products in your own production line, we've mounted a 6,000 gal./hr. capacity unit on a movable skid that is completely integrated with the required pumps, valves, controls, and other accessories.

All you need is an available 220/440 three-phase electrical service and you're in business.

This first of a series of packaged test units is available on a leasing agreement set to meet your particular needs.

They supplement a test program which has operated for some time now in our Pfaudler labs. They should prove of great value where you have products that are perishable or otherwise difficult to ship or whenever you prefer to do your own in-plant testing.

We will also provide technical personnel for setting up and operating the test program.

An outstanding feature of these centrifuges is their ability to desludge themselves automatically. In normal operation you can run them continuously for weeks without a major shutdown for cleaning.

For more information on the leasing program, see your local Pfaudler Permutit representative. Write for bulletin on the centrifuges to our Pfaudler Division, Dept. CE-39, Rochester 3, N.Y.

Yes! . . . it's ALL STEEL

HP RANGE:
½ to 50 hp

RATIOS:
4:1—14:1—24:1 (or 20:1)

OUTPUT SPEED RANGE:
420 to 5 rpm

TORQUE RATINGS:
up to 41,000 lb-in
(Consult factory for higher torque capacity)

FALK ALL STEEL Shaft Mounted Drive

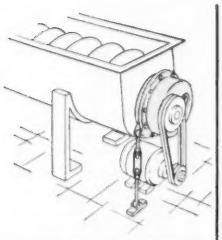
. . . Steel can "take it"!

STEEL frame . . . of fabricated plate supports all rotating elements—provides double the ability of iron to maintain vital alignment of revolving elements, even under shock load or external impact.

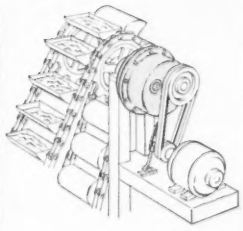
STEEL housing . . . will not fracture, serves only as protective cover and lubricant reservoir. Therefore, lubricant supply is safeguarded.

STEEL tie-rod and straddle-mounted tie rod brackets . . . are fastened to heavy steel frame by steel bolts in double shear.

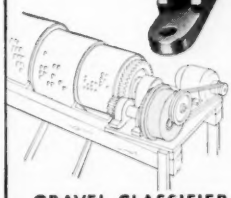
A FEW TYPICAL APPLICATIONS



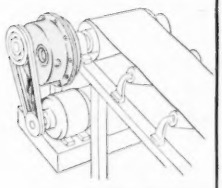
SCREW CONVEYOR



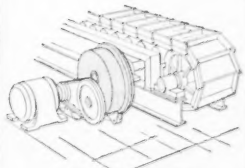
BUCKET ELEVATOR



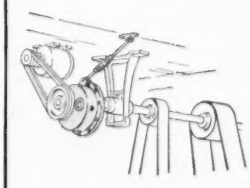
GRAVEL CLASSIFIER



BELT CONVEYOR



APRON FEEDER



LINE SHAFTING

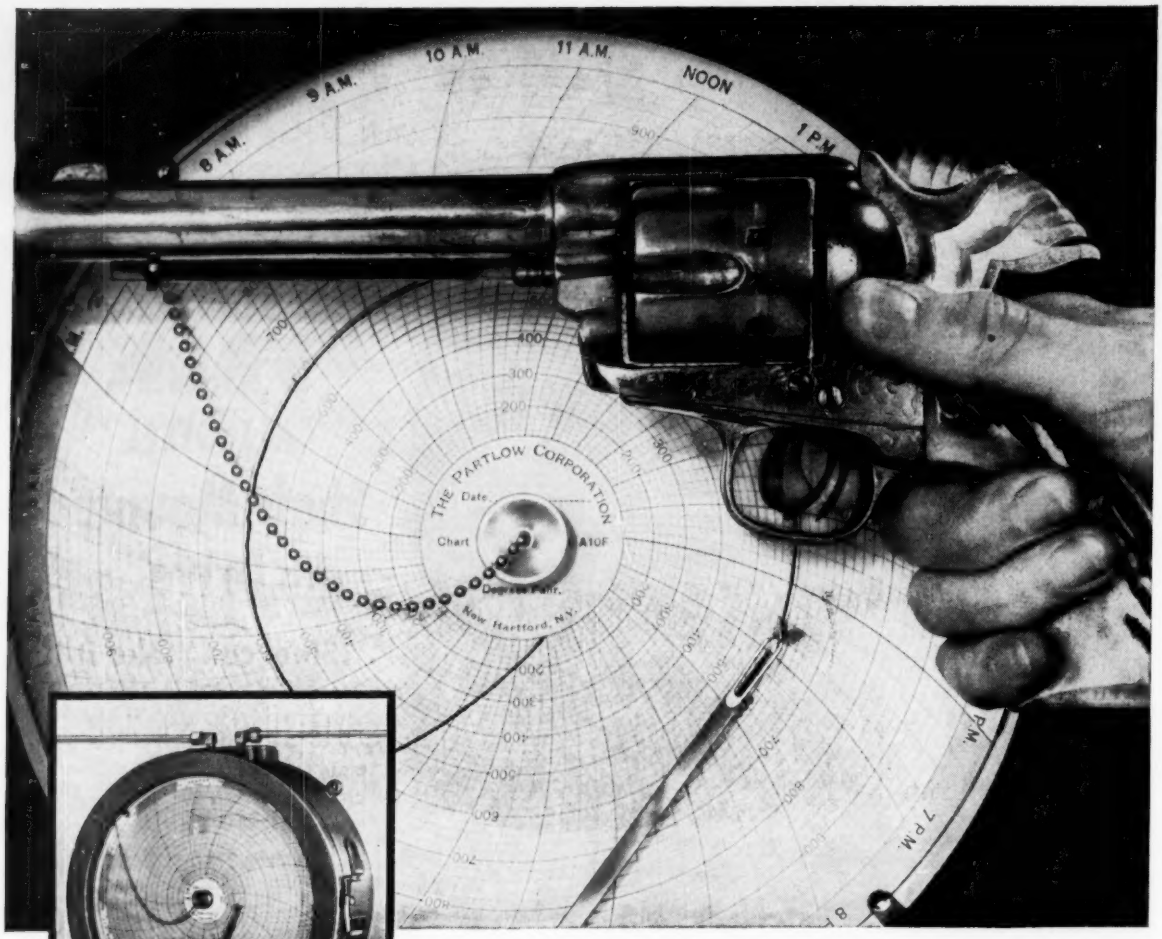
DELIVERIES TO MEET YOUR REQUIREMENTS

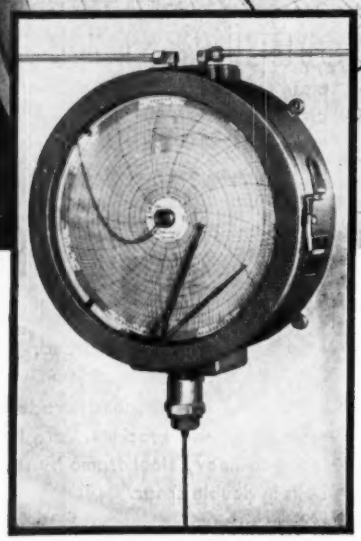
Off-the-shelf delivery from your Authorized Falk Distributor. *Shipment from factory or warehouse stocks* within 72 hours after receipt of your order.

Write for Bulletin 7100

THE FALK CORPORATION, 3001 W. CANAL ST., MILWAUKEE 1, WIS.
Representatives and Distributors in Most Principal Cities
Manufacturers of Quality Gear Drives and Flexible Shaft Couplings

FALK
. . . a good name in industry





The Control Geared for

HAIR TRIGGER RESPONSE

even to Fractional Changes in Temperature!

NEW *Recording Pneumatic Temperature Control, Model RVA, available in any of 10 ranges from -30° to 1100° F.*

Extreme sensitivity—reflected in lightning-fast reaction to temperature changes—is a characteristic of *all* Partlow controls. Partlow Recording controls, however, *prove it in writing* . . . You can see for yourself how exceptional bulb sensitivity, teamed with advanced mechanical design, provide a minimum of "saw-toothing" on start-up, and maintain a rigid line of control when temperature reaches a predetermined set point.

Instant response, of course, is just one of Partlow's many built-in advantages. Another is rugged *design simplicity* that does away with hair springs and delicate electronic gadgets . . . that requires no electronic amplification . . . that permits fast, "screwdriver" replacement of the thermal element *right out in the field.*

If you use or manufacture process equipment within the -30° to 1100° F. range, there's a Partlow Pneumatic, electric or self contained gas control to fit your application *precisely*. Recording, indicating and non-indicating models available. For full details write The Partlow Corp., New Hartford, New York, Dept. E-359.

Export Reps: Ad. Auriema, Inc., 89 Broad St., New York 4, N. Y.

You can pay more but you can't buy better than

PARTLOW

TEMPERATURE CONTROLS

WOLVERINE TRUFIN®

SAVES YOU MONEY

8 WAYS

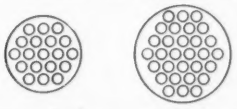
Anytime you cut down costs, you pep up the profit picture. Here's an idea: where heat exchange costs are concerned, Wolverine Trufin Type S/T—the integral finned condenser tube—can help you save money *eight* ways. Take a look at the points listed below. They can open the door to substantial savings, provide added dividends in increased efficiency.

✓ Because Trufin is an extended surface tube—with fins extruded right from the tube wall—it has more than twice the heat transfer surface of plain tube. Less tube is required because Trufin transfers more BTU's per foot of tube.

✓ Fewer tubes mean smaller shells, headers, baffles, etc. This saves material requirements.

✓ Fewer tubes mean fewer holes to drill—less rolling-in operations. Direct result: substantial savings in labor costs.

✓ To transfer a given heat load—when Trufin is used—much less weight of over-all tube metal is required. This is a real saving when expensive alloys are necessary. This is of greatest importance when alloys are in short supply, as a given quantity of metal in Trufin transfers much greater heat loads.



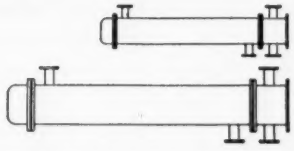
FEWER TUBES
MEANS SMALLER SHELLS

✓ Because of these material savings, lighter units—requiring less structural support—can be designed. This is vital when exchangers are to be mounted on superstructures.

✓ Maintenance costs are low. Costs of replacement tubes are reduced; fewer tubes result in less cleaning time, more "on stream" time. Actual operating data proves that Trufin withstands fouling for longer periods than does prime surface tube. This increases the length of operating time between change-overs.

EQUIVALENT TUBES
WITH THE SAME SURFACE

✓ Smaller, lighter units result in easier handling and lower shipping costs.



TRUFIN
MEANS
SMALLER
UNITS

✓ Where space is at a premium—as in revamped units—Trufin units are smaller.

There they are—eight job-proven ways in which Wolverine Trufin Type S/T condenser tube can save you money. Write for a copy of Wolverine's new Trufin Catalog today!

CALUMET & HECLA, INC.
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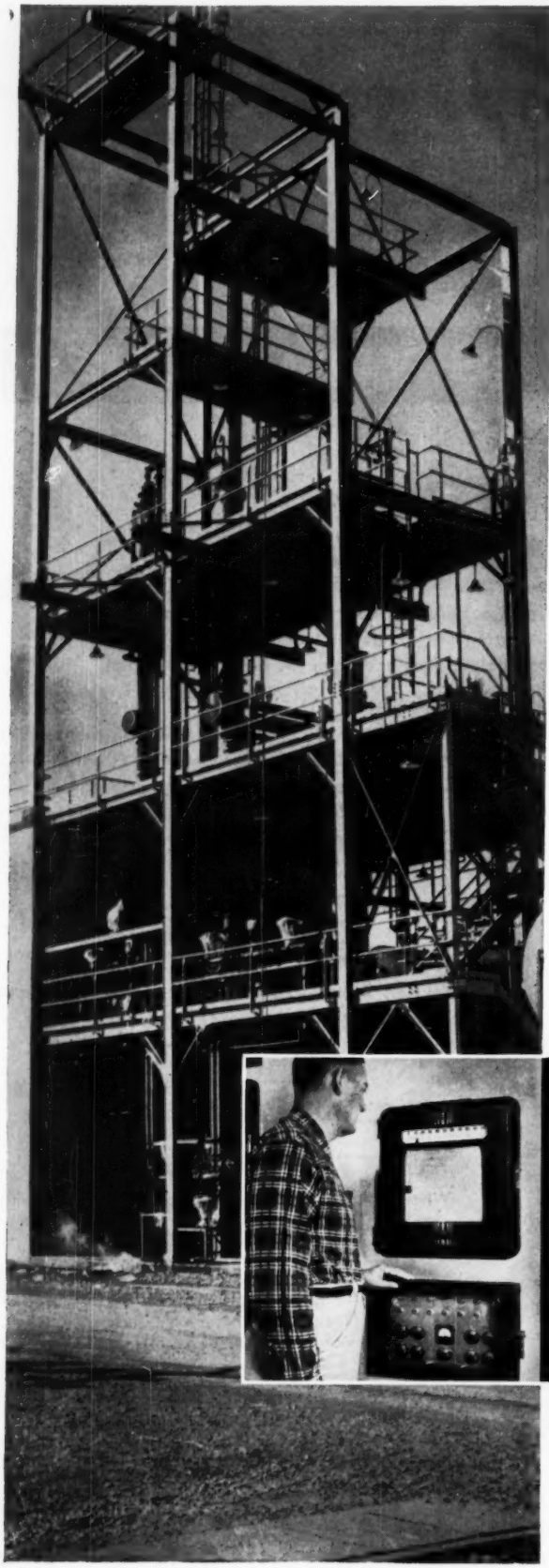
WOLVERINE TUBE
DIVISION OF
CALUMET & HECLA, INC.
17232 Southfield Road
Allen Park, Michigan
Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

Wolverine Trufin is available in Canada through the Unifin Tube Division, London, Ontario.

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES



New

CHROMOMAX*

helps Pennsalt boost product quality

For more than six months, Pennsalt Chemicals Corporation at Calvert City, Ky. has based control of its Isotron plant on Chromomax data. Component concentrations as low as 0.01% are detected and measured by this highly sensitive L&N Chromomax Gas Chromatography Analyzer. It enables Pennsalt's operator to monitor impurity levels every 10 minutes . . . to make any necessary control adjustments. The result: the refrigerants and aerosol propellents produced have a purity of more than 99%.

Pennsalt also relies on Chromomax because it's dependable . . . needs only routine maintenance . . . requires simply a weekly check against a standard sample. The instrument maintenance group finds that programming cycles are easy to reset after a process changeover. These benefits confirm Pennsalt's policy of getting the best instrument for the application.

If you, too, have a process stream measuring problem, let L&N's versatile Chromomax Analyzer solve it . . . economically . . . dependably. If required, your Chromomax can be equipped with dual column switching or electronic integration.

Check with your nearest L&N Office for application details or write to Leeds & Northrup Company, 4916 Stenton Ave., Phila. 44, Pa. for information.

**Trademark*

In the control room of Pennsalt's Isotron plant, a process operator checks component variations on a Chromomax Analyzer as a guide to resetting control points.

LEEDS NORTHRUP
Instruments Automatic Controls • Furnaces

ADVERTISEMENT—*This entire page is a paid advertisement* *Prepared by U. S. Industrial Chemicals Co.*

U.S.I. CHEMICAL NEWS

Mar. ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1959

World's Largest Industry-Owned Research Reactor Opens at Plainsboro, N. J.

U.S.I. One of Ten Participants

On January 19, Industrial Research Laboratories, Inc. (I.R.L.) — the world's largest nuclear reactor financed entirely by private funds and devoted solely to industrial research — made its formal bow at Plainsboro, N. J. U.S.I. and nine other companies are participating in the venture, using the reactor as a tool for basic and applied studies in many fields.

The fields of interest of the participants include alcohol, chemicals, special metals, plastics, tobacco, machine tools, explosives, packaging, glass, lead, electronics, oil and rubber. This wide range of interests will make I.R.L. a major contributor to the "Atoms for Peace" program.

The five-million-watt "swimming pool" type reactor is housed in an 87-foot-high, aluminum-sheathed "beehive" of reinforced concrete. It

MORE

Methionine Bibliography Now Available from U.S.I.

Readers of the November U.S.I. Chemical News have expressed tremendous interest in the lead story on methionine absorption through the skin. Hundreds of letters, telegrams and phone calls have been received asking for more complete information. To answer these many requests, we have prepared a selected bibliography of published articles on the oral and topical applications of methionine, which should prove very helpful to interested parties.

This bibliography is now available on request.

Have You a New Product To Tell the World About?

Make it routine to send your publicity releases on new products and developments to the Editor of U.S.I. Chemical News, often called the "Front Page of the Chemical Process Industries." The issue you are reading right now will be printed in over 250,000 copies of the leading publications serving the chemical and related fields. The Technical Developments column alone will probably produce over 600 inquiries, judging from the past average. You incur no charges or obligations by sending us your new product releases. The material will be judged and used solely on the basis of newsworthiness and space limitations. And of course we cannot guarantee that your item will definitely appear because of these considerations.

U.S.I. Reopens Second Chlorine-Caustic Unit At Huntsville, Alabama

Plant Ideally Located to Supply Growing Needs of Southern Textile and Pulp and Paper Industries

U.S.I. increased chlorine and caustic soda output at Huntsville, Alabama recently, when a second unit was put back into operation. U.S.I. has been producing at this location since 1952. The Huntsville plant site offers the benefits of economic freight rates to a large number of users, and is therefore an ideal location from which to supply the chlor-alkali requirements of Southern textile and pulp and paper operations.

Liquid chlorine is available to users in 30-ton and 55-ton tankcars. The future possibility of barge shipments is being studied. Commercial grade, 50% liquid caustic soda is available in 8,000- and 10,000-gallon insulated and lined tankcars as well as in barges.

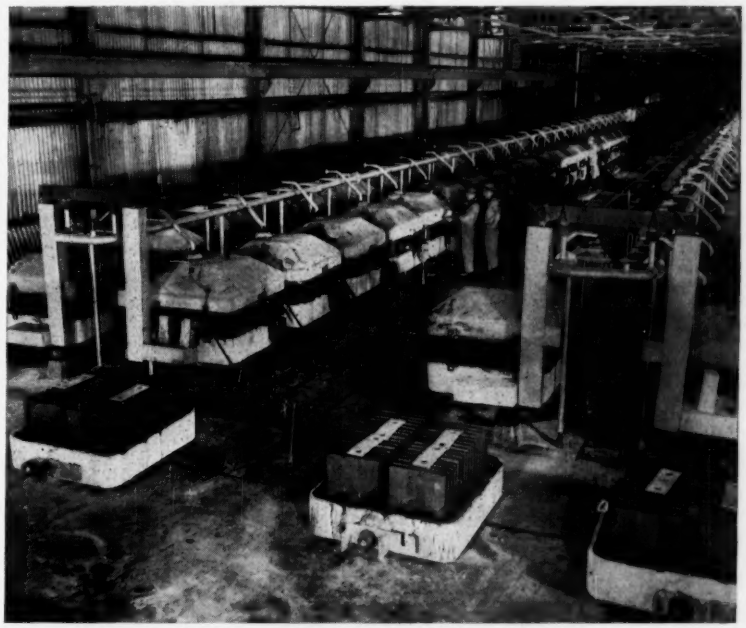
Both chlorine and caustic soda — products of the electrolytic decomposition of brine — are among the top dozen industrial inorganic chemicals produced in the United States today, in terms of tonnage. In 1957, the most recent year for which U.S. Department of Commerce figures have been reported, 3.9 million short tons of chlorine were marketed, and 4.0 million short tons of caustic soda, on a 100% NaOH basis, were sold.

MORE

Colognes Estimated Sixth In Aerosol Sales in 1958

Early estimates indicate that aerosol cologne sales for 1958 stand at over 26 million units. This would be an increase of about 50% over the 1957 sales figure of 18 million units. U.S.I. reports that the rise in its sales of anhydrous alcohol from 1957 to 1958 for aerosol cologne applications supports this estimate. Industry spokesmen reveal that 1958 was the first year in which aerosols accounted for over half the cologne market, in terms of dollar volume.

In 1958, as in 1957, colognes will probably rank sixth in unit sales among aerosol products, when all figures have been tabulated. The 1958 sales volume ranking should look much as it did in 1957, with hair sprays, shaving lathers, room deodorants, insect sprays and coatings taking the first five places.



Cell room of chlorine-caustic soda unit, U.S.I. plant, Huntsville, Alabama.

Mar. ★ **U.S.I. CHEMICAL NEWS** ★ 1959

CONTINUED

Chlorine & Caustic

Chlorine End-Use Pattern by Industry

INDUSTRY	PERCENT OF TOTAL
Pulp and Paper	15.0
Chlorinated Solvents	13.0
Automotive Fluids	11.0
Plastics and Resins	11.0
Insecticides and Herbicides	7.5
Refrigerants and Propellants	5.0
Water and Sewage	3.5
All Others	34.0
TOTAL	100.0

Caustic Soda End-Use Pattern (Estimated)

END-USE	PERCENT OF TOTAL
Chemicals	26.9
Rayon and Film	17.8
Pulp and Paper	6.6
Export	5.8
Petroleum Refining	5.5
Lye and Cleansers	4.1
Textiles	3.5
Soap	2.1
All Others	27.7
TOTAL	100.0

Organic Derivative of Hypochlorous Acid Being Tested in Cancer Surgery

Surgeons are testing an organic derivative of hypochlorous acid — a form of monoxychlorosene — as a wash for cleaning cancer wounds after operating. Used in this manner, the material has been successful in halting the growth of cancer cell seedings in rats after cancers had been removed surgically. The chemical is not a cancer cure however.

The material is being employed widely in cancer operations on humans at the present time. Thus far the usual post-operative tests via supravital staining techniques reveal that all cancer cell seedings remaining in and around the wounds are destroyed by the wash.

The hypochlorous acid raw material for this compound is unstable and not available commercially. It must be prepared by the reaction of chlorine with water.

CONTINUED

Reactor

is producing its chain reaction under 37 feet of demineralized water which serves as moderator, coolant and shield. The unit provides a source of neutrons, gamma rays and radioactive isotopes for study.

A permanent staff of 30-40 scientists and technicians is operating the reactor. In addition, participating companies maintain permanent staffs in individual research laboratories.

U.S.I. Studying Processes, Products

U.S.I.'s participation in this new undertaking is one more step in its expanding research program. Basically, its investigation will cover nuclear radiation for initiating or modifying chemical reactions, for controlling production processes, and for developing and testing new products.

Technicians load core of new I.R.L. nuclear reactor with fuel elements preparatory to start of operation. Core is 37 feet below surface of water which acts as coolant, shield.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

Sodium and potassium borohydride information is presented in 34-page manual now available. Properties, reactions, handling are discussed. Thirteen tables cover technical data collected from other published works. **No. 1450**

The 1958 edition of "Annual Review of Biochemistry" can now be purchased. It is a 775-page volume, containing 22 sections by different authors, covering developments in all biochemical fields. **No. 1451**

Heat transfer coefficients in small sodium heat exchangers are discussed in a reprint now available. Empirical equations are developed for calculating the over-all heat transfer coefficients for tube and annulus exchangers. **No. 1452**

Molybdenum hexacarbonyl is now available commercially for use as a chemical intermediate, catalyst and vapor phase deposition raw material. Compound and derivatives are under study for dyes, toners, lube additives, etc. **No. 1453**

Rotating-cylinder viscometer, designed for measurement of liquids at very low shear stresses, is now on market. Claimed to be particularly useful for accurate studies of high-molecular-weight polymers. **No. 1454**

New aluminum soap has been developed to gel solvents without use of heat. Bulletin now offered on product tells how to form stable gels from non-polar solvents and mixes of polar and non-polar solvents. **No. 1455**

Automatic, lab-bench zone refiner just developed will give high-purity organic reagents from run-of-bottle chemicals. Said to purify any material with 50-300°C M.P. Greatest use seen for organics hard to refine by usual means. **No. 1456**

Butene-1 can now be obtained with liquid vol. analysis of 98.5% butene-1, 0.0% isobutylene and butadiene, 0.8% n-butane, 0.7% butene-2. Butene-2 now obtainable with 95.0% butene-2, 0.5% butene-1, 1.0% butadiene, 3.5% n-butane. **No. 1457**

Standard fuel elements in 4 types, for use in low-power research reactors, now on market. Availability of standard elements claimed to greatly reduce costs of custom design, special tooling and set-up, special engineering. **No. 1458**

Methyl borate is now available commercially in carload quantity. Material is a widely-miscible, non-aqueous solvent, azeotroping agent, Lewis-acid catalyst and intermediate. Also acts as a neutron absorber and detector. **No. 1459**

PRODUCTS OF U.S.I.

HEAVY CHEMICALS

Caustic Soda, Chlorine

Sodium, Metallic: cast solid in tank cars, steel drums, pails; bricks in barrels, pails.

Sodium Peroxide, Sodium Sulfite, Sodium Sulfate

Ammonia, Anhydrous: commercial & refrigeration. Tank cars or tank wagons.

Ammonium Nitrate, Nitric Acid, Nitrogen Fertilizer Solutions

Phosphatic Fertilizer Solution: wet process phosphoric acid.

Sulfuric Acid: all strengths, 60 Baume to 40% Oleum. Also Electrolytic grade to Federal specifications. Tank cars or tank wagons.

OTHER PRODUCTS

PETROTHENE® Polyethylene Resins

Pharmaceutical Products: DL-Methionine, N-Acetyl-DL-Methionine, Urethan USP, Riboflavin USP, Intermediates.

Alcohols: Ethyl (pure and all denatured formulas); Proprietary Denatured Alcohol Solvents SOLOX®, FILMEX®, ANSOL® M, ANSOL PR.

Organic Solvents and Intermediates: Normal Butyl Alcohol, Amyl Alcohol, Fusel Oil, Ethyl Acetate, Normal Butyl Acetate, Diethyl Carbonate, DIATOL®, Diethyl Oxalate, Ethyl Ether, Acetone, Acetoacetanilide, Acetoacet-Ortho-Chloranilide, Acetoacet-Ortho-Toluidide, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethylene, Ethyl Sodium Oxalacetate, Sodium Ethylate, ISOSEBACIC® Acid, Sebacic Acid, Urethan U.S.P. (Ethyl Carbamate), Riboflavin U.S.P., Pelargonic Acid, 2-Ethyl Heptanoic Acid.

Animal Feed Products: Antibiotic Feed Supplements, BHT Products (Antioxidant), Calcium Pantothenate, Choline Chloride, CURBAY B-G®, Special Liquid CURBAY, VACATONE®, Menadione (Vitamin K_3), DL-Methionine, MOREA® Premix, Niacin USP, Riboflavin Products, Special Mixes, U.S.I. Permadry, Vitamin B_{12} Feed Supplements, Vitamin D_3, Vitamin E Products, Vitamin E and BHT Products.

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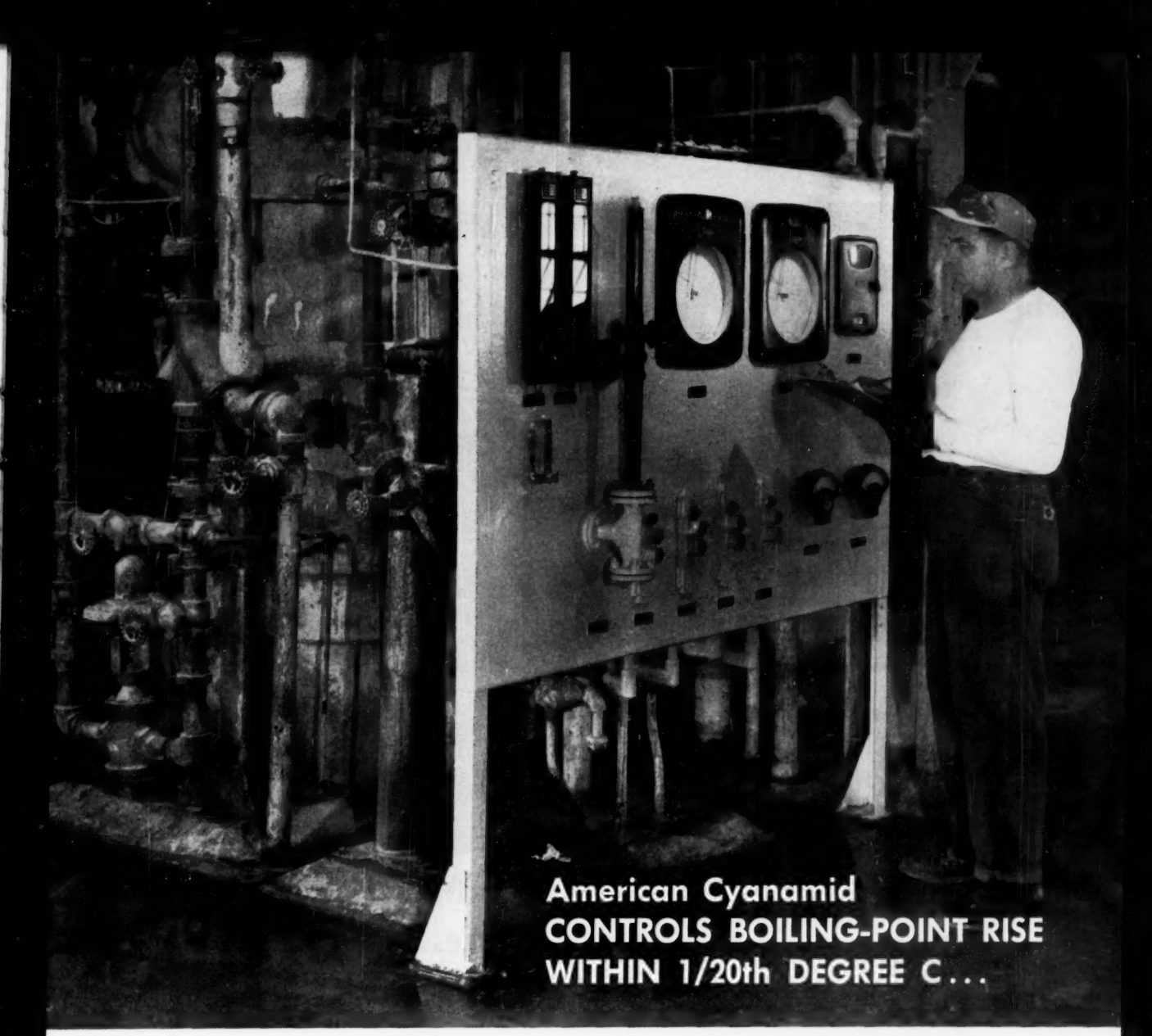

by unique narrow-span DYNALOG* Electronic Controller

Temperature difference control within ½ of 0.1°C — that's what American Cyanamid demands for process evaporators at their Organic Chemicals Plant in Bound Brook, New Jersey. Boiling-point rise must be held at 108.5°C, since even slight variations affect product quality.

A Foxboro Dynalog Recorder-Controller, with full-scale span of only 5°C, provides the close control American Cyanamid requires. Control is held continuously within 1/20th of a degree of set point — with chart records for proof.

Cyanamid's Narrow Span Controller was installed in 1955. It's been running continuously ever since, virtually unattended. The only servicing or maintenance required on the Dynalog has been re-inking and chart changing.

Get the complete story on the exclusive Dynalog Controller, with full-scale spans as narrow as 5°F — the narrowest span available to industry today! Write for Bulletin 20-10. **The Foxboro Company, 363 Neponset Ave., Foxboro, Mass.** **Reg. U. S. Pat. Off.*

FOXBORO
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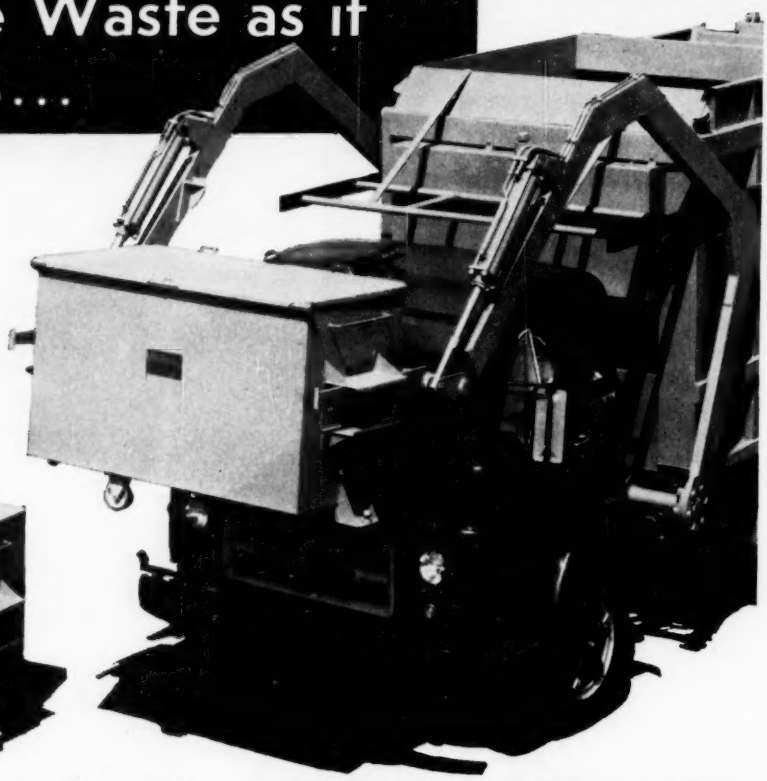
DYNALOG ELECTRONIC INSTRUMENTS

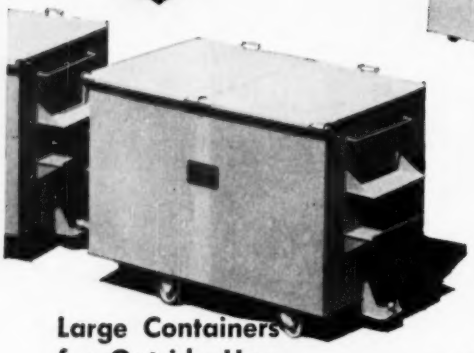
cut disposal costs by two-thirds...

Containerize Waste as it Accumulates...

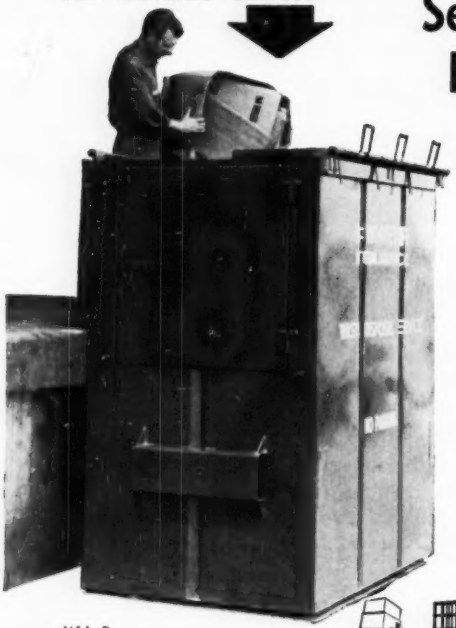
Patents Pending



Small Tracking Containers for Indoor Use...



Large Containers for Outside Use...



Self-Loading DEMPSTER-DUMPMASTER Handles 6 Sizes of Containers...

If you're using boxes, bins, cans or carts to handle or store big-volume waste and refuse, you can reduce costs by more than two-thirds with the new DEMPSTER-DUMPMASTER System of waste storage and collection.

One Dumpmaster serves any number of detachable metal containers placed at waste accumulation points. Making its rounds, the Dumpmaster picks up each container, in turn, empties the contents into its packer body and compresses the material to a fraction of its former volume assuring big pay loads on every trip to the disposal area.

The DEMPSTER-DUMPMASTER is economical! One man operation. It's safe! Clearance lifting arms never pass the cab windows, can't injure operator. Containers can be used indoors or outdoors, on ground, below grade or on a dock.

This system is also available on a monthly fee basis through a nearby DEMPSTER-DUMPMASTER equipped private hauler, (name furnished on request).

WRITE TODAY FOR FREE BROCHURE

DEMPSTER DUMPSTER® SYSTEMS

Mfd. By DEMPSTER BROTHERS Inc.

Dept. CE-3 DEMPSTER BROTHERS, Knoxville 17, Tennessee

"SPECIAL" Welding Fittings

by MIDWEST

"SPECIAL" DESIGNS

"SPECIAL" MATERIALS

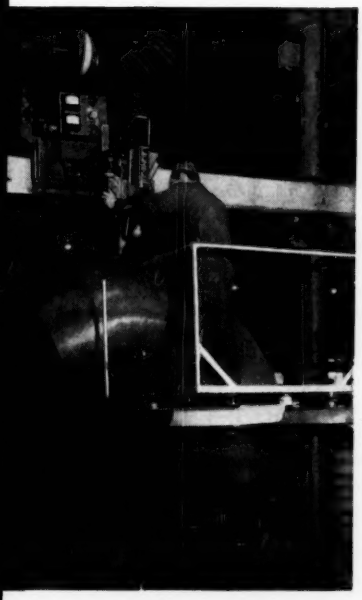
"SPECIAL" QUALITY

"SPECIAL" DELIVERY

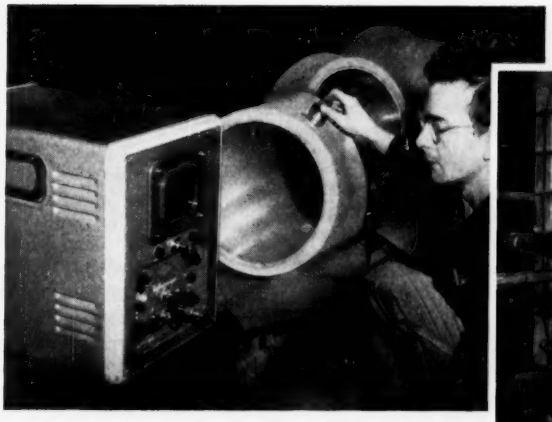
Special gauges and instruments are used to make sure that we have complied with the extremely close tolerances often required on stainless fittings. Here wall thickness and concentricity were held within extremely close limits throughout the fittings.

The exclusive Midwest method of manufacture—much more versatile and flexible than any other—enables us to make almost any type of special welding fittings to the most rigid specifications. Midwest makes welding fittings from *plate* . . . usually much easier to get than pipe, particularly if the material is special. That expedites delivery. Closer tolerances are inherent in the Midwest process, and quality control is always beyond code requirements.

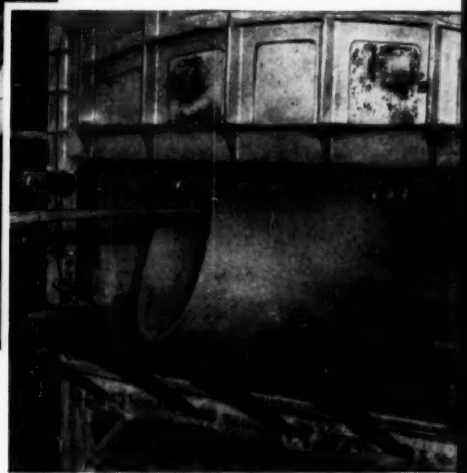
Even if you use only standard fittings, the exceptional quality of Midwest fittings can be important to you. Ask your Midwest distributor or write us for new Bulletin 5801.



36" O.D. 90° elbow with 16" tangent on one end being welded by an automatic submerged arc machine. Material is A-201 carbon steel.



Stainless-clad elbows undergoing ultrasonic inspection to check bonding of material and quality of weld. Since plate is often the only form in which clad material is available, the Midwest process is able to produce the most comprehensive range of clad fittings—and to do so promptly.



Special 24" x 21" 45° reducing elbow made of 1" thick 1¼% chrome ½% moly steel ready for heat treating furnace.

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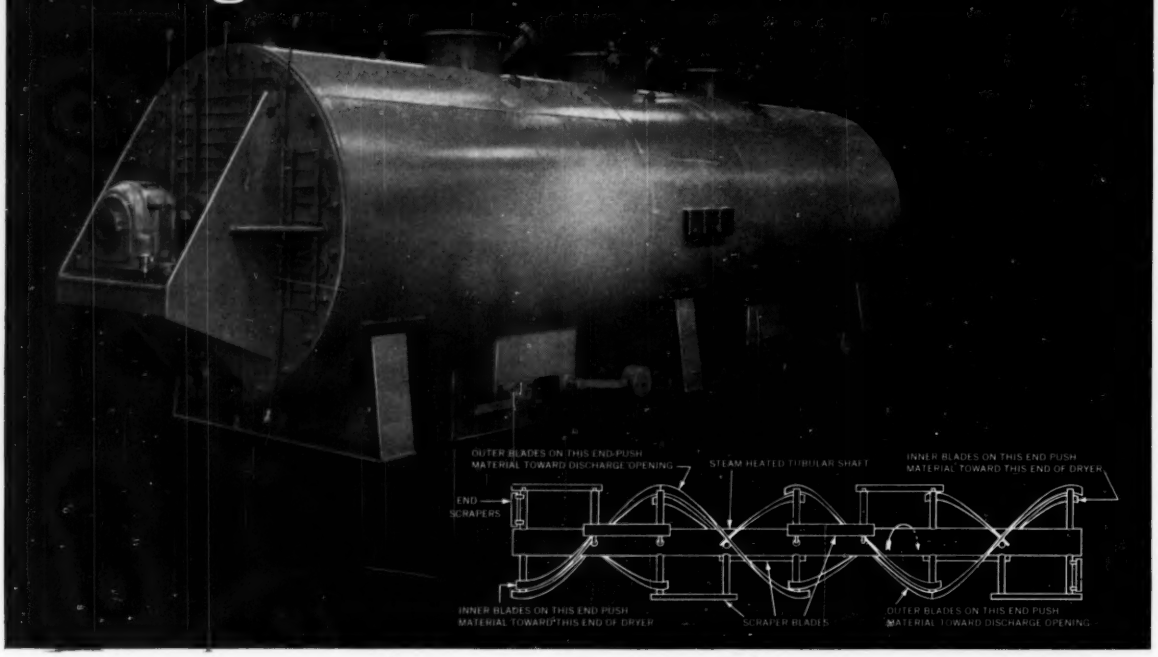
design makes the difference!


OUTER BLADES ON THIS END PUSH MATERIAL TOWARD DISCHARGE OPENING
STEAM HEATED TUBULAR SHAFT
INNER BLADES ON THIS END PUSH MATERIAL TOWARD THIS END OF DRYER
END SCRAPERS
INNER BLADES ON THIS END PUSH MATERIAL TOWARD THIS END OF DRYER
SCRAPER BLADES
OUTER BLADES ON THIS END PUSH MATERIAL TOWARD DISCHARGE OPENING

Unique agitator design speeds production in Stokes rotary vacuum dryers

There's only one sure way to lower drying costs and boost production—remove more moisture from more material in less time. This double-spiral agitator . . . exclusive with Stokes rotary vacuum dryers . . . does just that.

The double spiral keeps all the material moving . . . continuously mixes and braids it, puts all parts of the load in contact with heated drying surfaces, and eliminates agglomerates. Production is further speeded by the steam-heated agitator shaft and arms, which increase effective drying surface up to 25%. And the smooth, even operation of the entire unit minimizes load fluctuations, keeps power requirements low.

To assure complete product discharge, Stokes custom fits each assembly to its dryer shell. Blade clearance is adjustable down to $\frac{1}{8}$ inch.

Functional features like these—the result of Stokes' long experience in designing and manufacturing vacuum process equipment—are found throughout the entire rotary vacuum dryer. Equally important features are built into Stokes cone vacuum dryers, drum dryers and flakers for the chemical and processing industries. In each case, Stokes design is your guarantee of unequalled efficiency and economy.

Stokes Advisory and Engineering Service, with its fully-equipped laboratory, is available to help you solve drying problems and plan for profitable production. For full information, write to Stokes or contact your nearest Stokes office.

Vacuum Equipment Division
F. J. STOKES CORPORATION
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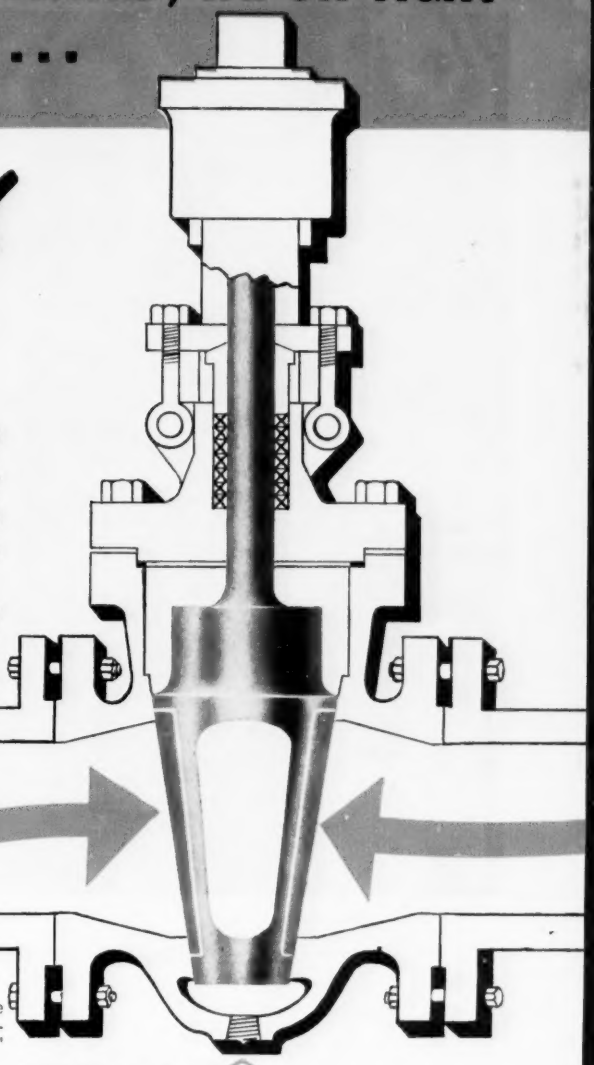
STOKES

STOCKHAM'S NEW, NON-LUBRICATED, VAPOR-TIGHT WEDGEPLUG "O-SEAL" VALVE . . .

DOES THE WORK OF 2 VALVES!



rovides Double-Block & Bleed in Most Services

ere's the valve you've been waiting for—Stockham's new Wedgeplug* O-Seal." It not only solves all your leakage problems for good **without brication**—but also does the work of 2 valves or a line blind. That's al economy!

The two Teflon* "O" rings in the plug do the trick—give constant apor-tight shut-off on both the upstream and downstream seats. And e "O-Seal" is **non-lubricated**—cuts maintenance costs **from now on!**

Because of the double pressure-sealing effect of the "O" rings, the upstream seats as well as the downstream seats of this new valve hold "bubble-tight" against line pressure.

The plug in the bottom boss can be pulled to provide the **tell-tale bleed.** In extensive field and laboratory tests, this valve held bottle-tight on the upstream as well as the downstream seats when the bottom plug was removed. There is absolutely no mixing of products in manifolds.

Thus the "O-Seal" can do the job of two ordinary valves or a line blind in most services.

Your Stockham representative will advise you about the recommended services for the "O-Seal's" double-block and bleed feature.

TELL-TALE BLEED

RECOMMENDED USAGES

Stockham's new "O-Seal" is recommended for all general services—air, gas, water, steam, propane, hydrocarbons, etc., as well as for hard-to-hold services. Recommended for temperatures from minus 300° F to plus 400° F and not exceeding 720 psi.

Available in carbon and alloy steels, 2"- 12" sizes, 150 and 300 lb. pressures. Three port openings—40%, 70%, full round-wrench, handwheel, gear, and motor operated.

OTHER OUTSTANDING ADVANTAGES — Non-Lubricated—no costly maintenance necessary • Absolute shut-off that remains permanently "bubble tight" • Quick, easy operation—won't stick—ever • Double Seating for Double Safety—Ground metal-to-metal seat provides shut-off in case fire burns out "O" rings • No Product Contamination-Protected Seats.

*Patented
‡Teflon: Dupont Trademark

STOCKHAM'S NEW WEDGEPLUG "O-SEAL" VALVE

Call your STOCKHAM Distributor or Sales Representative for complete details, or write today for the new brochure on the Wedgeplug "O-Seal."

Stockham makes a *better* valve . . . for *every* job

WEDGEPLUG VALVE COMPANY *Division of*

STOCKHAM VALVES *and* FITTINGS

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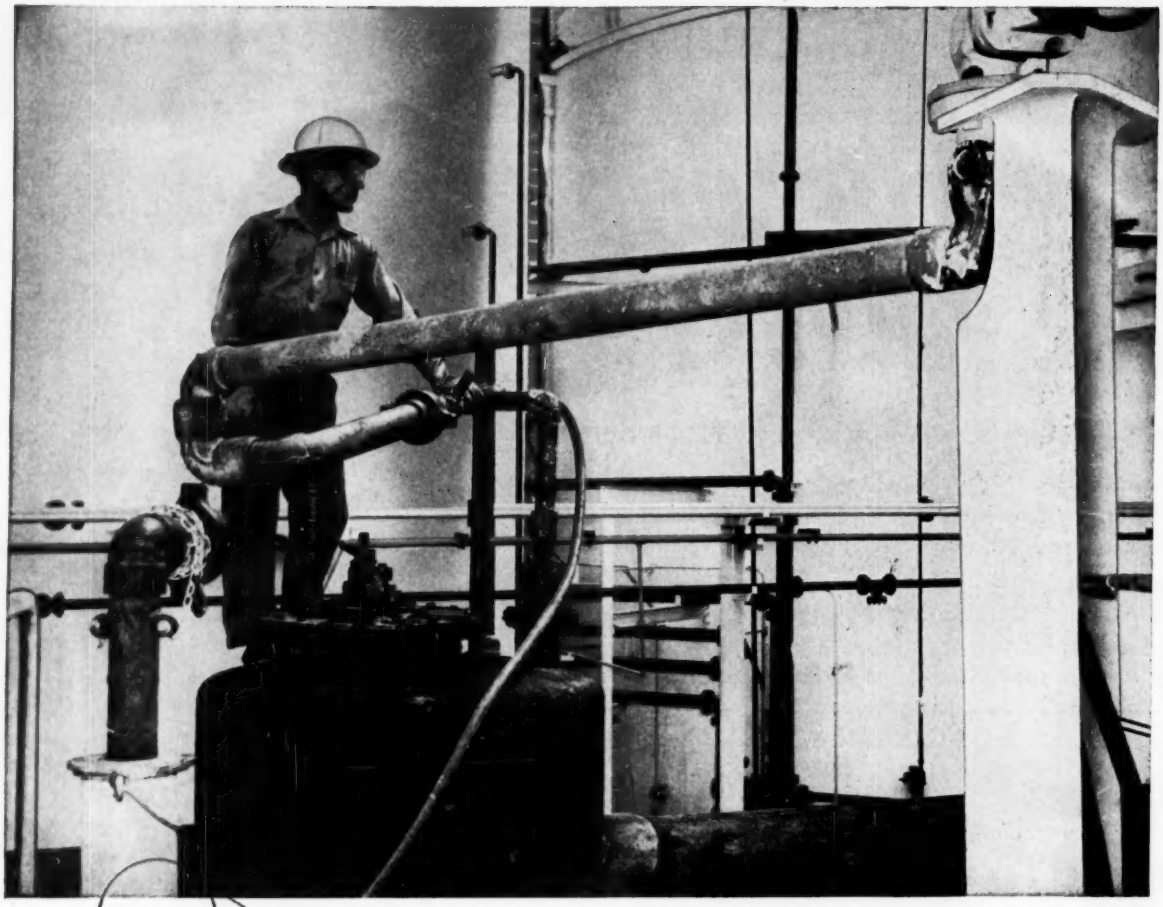
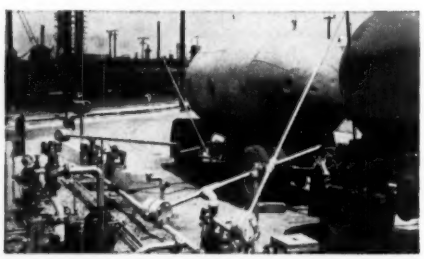
CAST IRON—MALLEABLE PIPE FITTINGS • BRONZE, CAST IRON, DUCTILE IRON, CAST AND FORGED STEEL VALVES



IN FLUID HANDLING— CHIKSAN

LOADING ARMS

give hard-to-handle liquids a
SAFE SEND-OFF . . .



Chiksan Loading Arms deal with hard-to-handle corrosive chemicals, hydrocarbons, and other fluids and gases, speedily and safely, in all kinds of weather.

Chiksan Loading Arms, with their versatile ball-bearing swivel joints, combine unlimited flexibility with the safety and longevity of metal. With Chiksan there's never a problem of hazardous, often costly, line rupture loss. In fact, whatever fluid you are handling, you get longer life, spend less on maintenance, with Chiksan Loading Arms. Write for descriptive literature today.

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

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CHIKSAN

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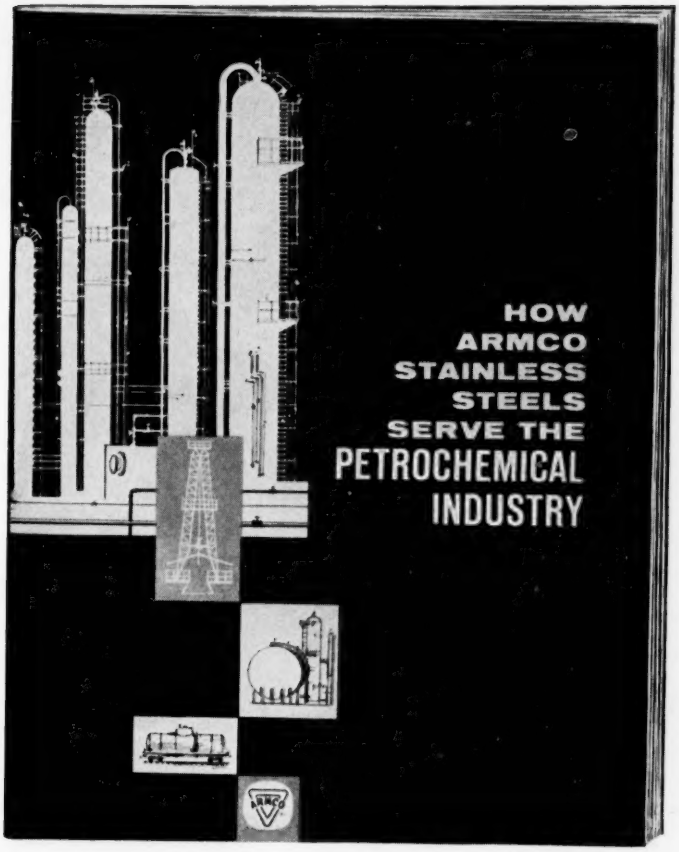

New steels are born at Armco

New Armco Manual Offers Performance Data On Stainless Steels in Petrochemical Processing

This just-published Armco booklet summarizes factual information on stainless steel based on in-service corrosion tests and plant experience. It provides pertinent data on how and why stainless steels are being used by petrochemical producers to help achieve maximum production at minimum cost.

Key sections of the manual present a review of the performance of stainless in typical petrochemical plants, and the reasons why stainless steels solve material problems at low cost. Extensive corrosion data, obtained from in-stream exposures and analyzed by corrosion engineers, list test conditions, media, and comparative corrosion rates.

The manual also describes how Armco's special stainless steels can be used to overcome production problems and cut costs. Ask for your free copy of "How Armco Stainless Steels Serve the Petrochemical Industry." Just fill out and mail the coupon.

ARMCO STEEL CORPORATION
1719 Curtis Street, Middletown, Ohio
Send me a copy of your new booklet, "How Armco Stainless Steels Serve the Petrochemical Industry."

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ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

Case Type No. 1279.

Case Type No. 1379 is Alumalife, while similar case Type No. 1079 is Cast Iron.

Case Type No. 1377.

In such cases DURAGAUGES® naturally serve longer

You have a choice of three case materials–Alumalife®, a special aluminum alloy, Cast Iron, rugged and durable, Phenol, tough and rigid plastic–plus the unique "Maxisafe" design when you specify Ashcroft Duragauges.

All three case materials use a chrome plated, die-cast retaining ring to keep out harmful fumes and dirt. Case construction simplifies servicing–the entire system can be easily removed for recalibration or repair.

The "Maxisafe" case provides absolute protection to the viewer, easy and quick access to the tube and movement assembly. An integrally cast solid wall separates the dial from the tube and movement. A safety cover plate on the back is held in position by a knurled knob.

Regardless of your gauge case requirements, there's an Ashcroft Duraguage to do the job. Contact your local Ashcroft Gauge Distributor for complete facts.

Ashcroft Duragauges are available in pressure ranges from 15 psi (or vacuum) minimum to 100,000 psi.

CASE MATERIALS, TYPE NUMBERS, MOUNTING AND SIZES

CASE	TYPE NO.	BACK FLANGE	MOUNTING		CONNECTION		DIAL SIZE
			WALL	FLUSH	LOWER	BACK	
Black Alumalife	1379	Yes	Yes	Yes	Yes	Yes	4½", 6"
Black Cast Iron	1079	Yes	Yes	Yes	Yes	Yes	4½", 6", 8½" 10", 12"
Black Phenol, Turret Design	1279	No	Yes	Yes*	Yes	Yes	4½", 6", 8½"
Black Alumalife**	1377	No	No	Yes	No	Yes	4½", 6", 8½" 10", 12"

**May be flush mounted by using Flush Mounting Ring, Catalog No. 1278.*
***The 10" and 12" dial sizes are made in cast iron only.*

ASHCROFT PRESSURE GAUGES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

Each dominates in its field—
Each with "the teeth that make the difference"

In high speed dispersing with the Cowles Dissolver, those "teeth" mean greater volume, higher quality, complete control—in less space and at lower cost. It's because the unique teeth of the patented Cowles Impeller give the most effective mixing action yet developed. And Cowles scientifically engineered power and drive systems assure you of maximum horsepower delivery—with operational ease at all impeller speeds.

Cowles' exclusive "Multi-Phase" mixing action makes it most in demand for ultimate dispersion, dissolving, emulsifying and deagglomerating in processing solid-liquid, liquid-liquid and gas-liquid materials. Even viscosities in excess of 50,000 centipoises are easily handled by the Cowles. There is no surge, no splash. Easy to clean, too, and the self-cleaning impeller won't clog—you'll save on operator time.

Cowles engineers will be happy to work with you in adapting the Cowles to your materials, processes and present equipment. They can help solve your processing problems economically.

Let us prove it in your plant—at our risk.

SEE HOW THE COWLES IS SOLVING THESE PROBLEMS:
(Cases from Cowles APPLICATIONS ENGINEERING files)

1-B. Ester Gum Adhesives
Product containing 40% solids of ester gum made at rate of 500 gals. per hour. End product quite stable with particle sizes of less than 4 microns.

1-C. Filter Media Dispersions
Dispersions of diatomaceous earth, asbestos, cellulosic materials and combinations made to improve pressure and vacuum filters requiring an excellent filter coating for optimum results. Users report greatly increased efficiency of filtering equipment and product per man hour.

1-E. One Time Carbon Paper Formulas
Formulas including pre-wet iron blue press cake of approximately 35% mineral and 65% pigment being made faster and better. Cowles does quicker, more thorough job of breaking down cake into balance of formula used as application binder.

1-F. Synthetic Fiber Delusterants
Now made without oversize reject problem (formerly running as high as 30% dry weight of TiO_2) in less than 30 minutes per batch. Elimination of rejects paying for equipment.

MOREHOUSE COWLES

Write today for complete information and catalog.

MOREHOUSE-COWLES, INC., 1150 San Fernando Road, Los Angeles 65, California

REPRESENTATIVES IN PRINCIPAL CITIES • CONVENIENT LEASE AND TIME PAYMENT PLANS

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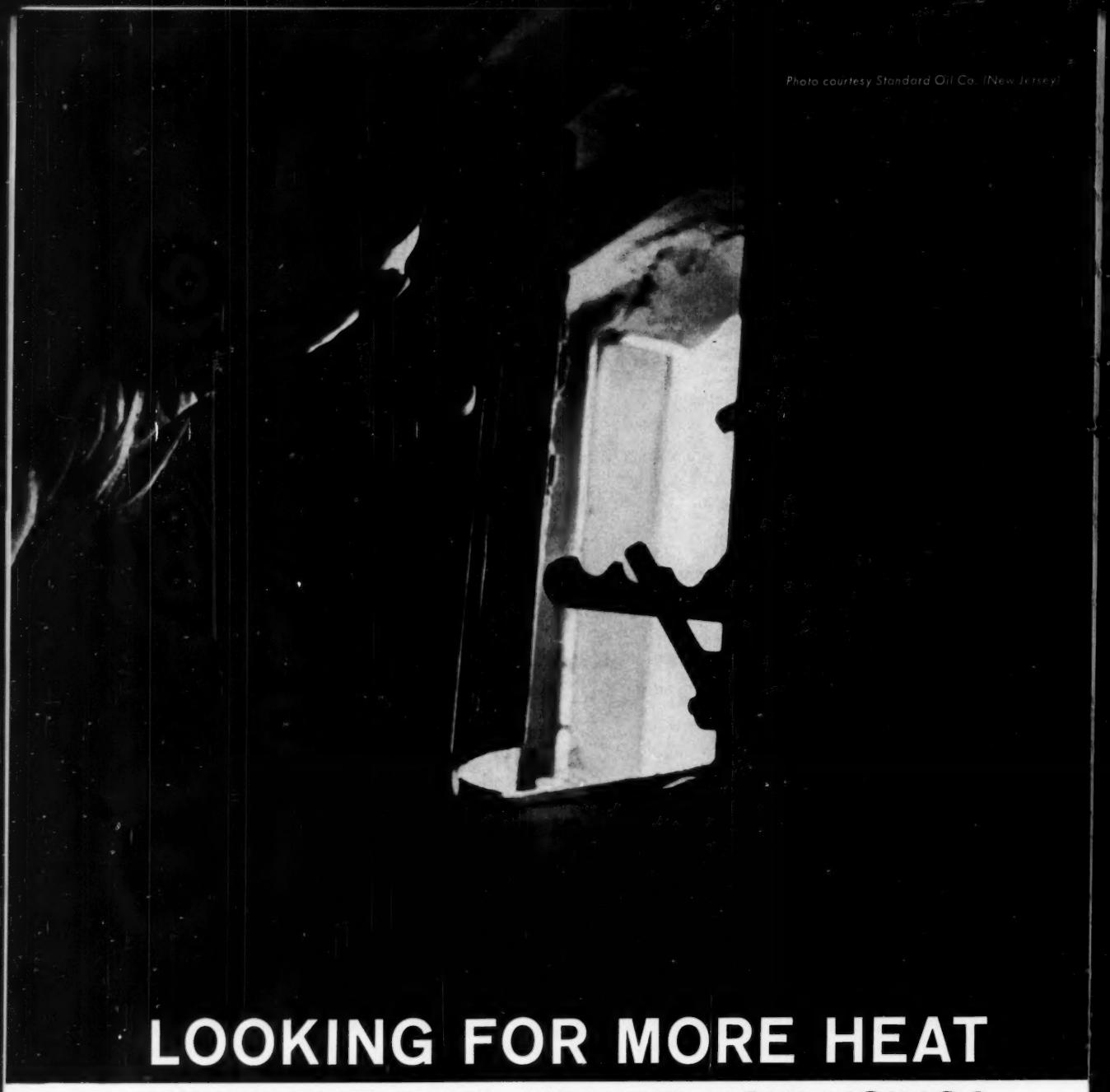


LOOKING FOR MORE HEAT

FROM THE FUEL YOU'RE NOW USING?

AN AIR PREHEATER CAN PUT AN EXTRA 1000° INTO YOUR FURNACE

You can get more heat – from the same amounts of your regular fuel – with a Ljungstrom® Air Preheater. An Air Preheater can recover as much as 1000°F from the exhaust of stills or boilers and return it to the combustion air of any kind of fuel-burning equipment. Extra furnace efficiency will in turn permit use of advanced boiler designs, finer controls and a more uniform, more profitable product.

You save fuel with preheated air, too. Even if you recover only 45°F from stack gas, you'll save 1% of your fuel bill. Recover 1000°F, and you can maintain present operating temperatures *on 20% less fuel.*

There's also less maintenance on a Ljungstrom-equipped furnace. Fuel burns more completely in preheated air, so there's less slag, fewer deposits, higher availability of equipment. What you save on maintenance and fuel alone will pay for your Air Preheater in two years or less. "Write-off" can be cut to *as little as nine months* if you use the extra capacity of a preheated furnace to boost product quality.

Free facts on fuel savings

One company's fuel savings with an Air Preheater are factually described in an article by Oliver F. Campbell. Write today for your free copy.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

COMPARE

More Capacity At Less Cost With R-C Rotary Gas Meters

R-C rotary gas meters are available in a wide range of sizes delivering "cash-register" accuracy in capacities from 2,000 to 1,000,000 cfh at pressures to 600 psig and are ideally suited for commercial, institutional, industrial, interplant accounting and pipeline metering.

Comparative Analysis	SPACE OCCUPIED	TOTAL CAPACITY	METER COST	INSTALLING COST	TOTAL COST
FOUR DIAPHRAGM METERS					
ONE R-C METER					

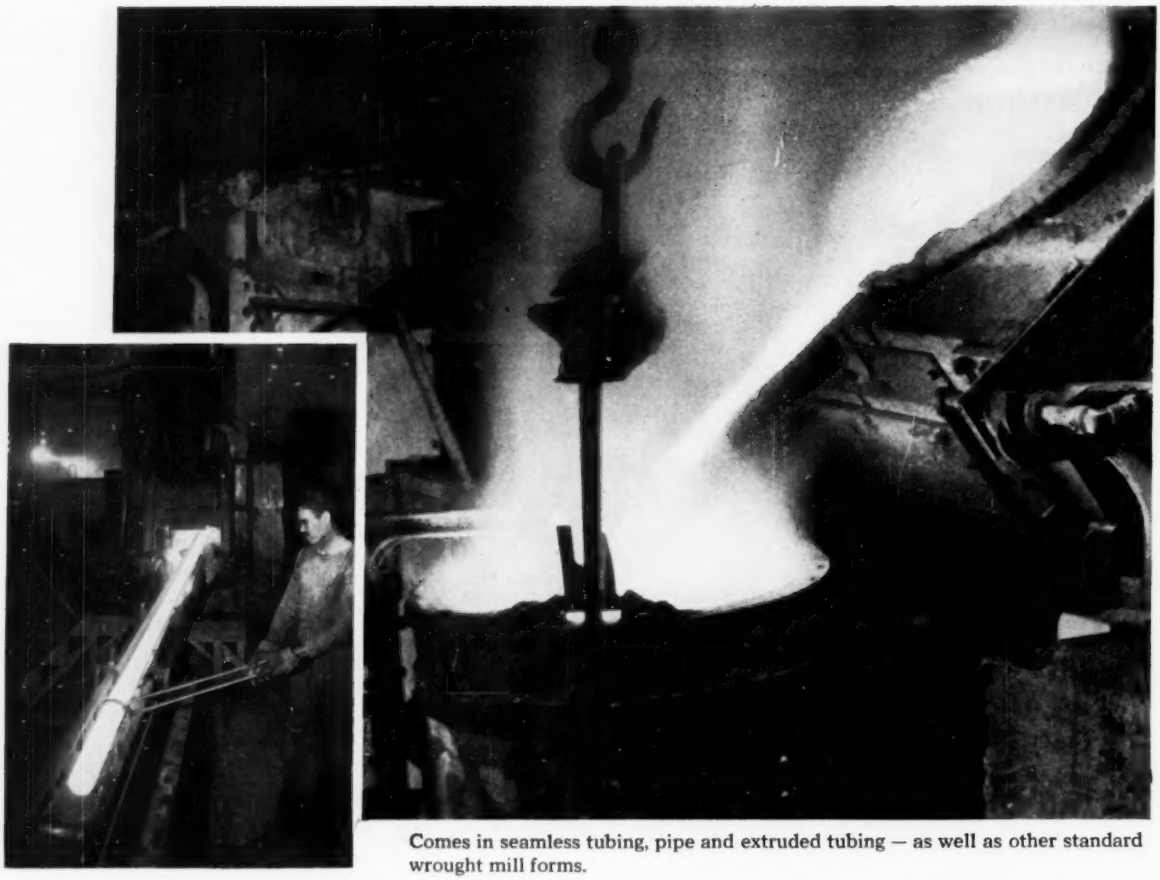
As the comparative chart indicates, cost is reduced and capacity is increased with R-C rotary positive displacement meters. The total capacity of one R-C meter exceeds that of two or more diaphragm meters. Both initial cost and installing costs are substantially lower. Their small space requirements permit installation in otherwise unusable space. And operating costs are held to a minimum, since maintenance is confined almost entirely to lubrication of gears and bearings and to an occasional check of the operating differential.

Roots-Connersville rotary positive displacement gas meters provide a 15:1 operating range – metering unmatched by any other design. Precision-machined measuring chambers insure unalterable accuracy unaffected by variations in specific gravity, rate of flow, pulsations or impurities. And there are no valves, diaphragms or other small parts to wear and cause inaccuracies.

Pressure drop is minimized, since R-C's straight-through design eliminates winding passages and restricting ports. Even at low flows, these meters retain "cash-register" accuracy. These advantages are the result of R-C's specialized experience of more than 100 years in the design and application of air and gas handling equipment.

For additional data, please refer to pages 565-568 in **Chemical Engineering Catalog,** *our section in* **Mechanical Catalog** *or write for* **Bulletin M-258**

ROOTS-CONNERSVILLE BLOWER
DIVISION OF DRESSER INDUSTRIES, INC.
359 Illinois Ave., Connersville, Indiana. In Canada—629 Adelaide St., W., Toronto



Comes in seamless tubing, pipe and extruded tubing — as well as other standard wrought mill forms.

Proved resistance to hot acids, oxidizing chemicals...NI-O-NEL

H_2SO_4

H_3PO_4

H_2SO_3

HNO_3

MANY MORE

Have you heard about Ni-o-nel?

It's Inco's new nickel-chromium alloy, containing molybdenum and copper, designed to withstand corrosive conditions of unusual severity.

Ni-o-nel* brings you outstanding resistance to certain hot acids — sulfuric, sulfurous, nitric and phosphoric acids. It resists such oxidizing chemicals as nitrates and cupric, ferric and mercuric salts (except the chlorides). It is highly resistant to most organic acids as well as to general corrosion, pitting and stress-corrosion cracking by sea water and other chloride-containing waters.

Where can Ni-o-nel be used? To handle sulfuric acid in many chemical processes and in petroleum refineries, detergent plants, rayon production and ore treatment. To handle sulfurous gases and condensates and pulp digester cooking liquors. In equipment for phosphoric acid production. In heat exchangers using chloride-containing cooling waters. And many other applications.

What forms are available? All standard mill forms, including plate, seamless condenser tubing, pipe and extruded tubing.

In Ni-o-nel you have an important new ally in the battle against difficult corrosive conditions. So learn all about it. The new booklet "Introduction to Ni-o-nel" describes composition, physical and chemical properties, suggested applications. Write for your free copy.

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

INCO

NI-O-NEL . . . for strong corrosives

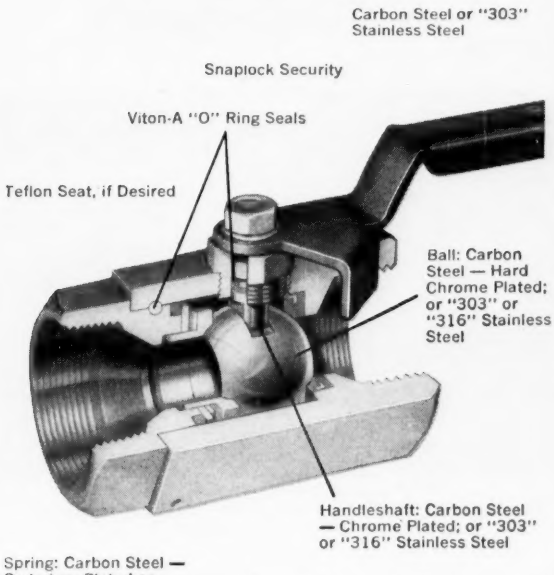
INCO NICKEL ALLOYS

Rockwood Ball Valves

Secure in seconds...

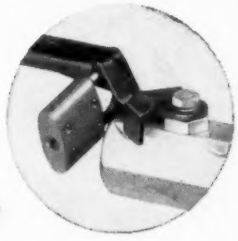
Snaplock Type

(now available with Viton-A trim)


Carbon Steel or "303" Stainless Steel
Snaplock Security
Viton-A "O" Ring Seals
Teflon Seat, if Desired
Ball: Carbon Steel — Hard Chrome Plated; or "303" or "316" Stainless Steel
Handleshaft: Carbon Steel — Chrome Plated; or "303" or "316" Stainless Steel
Spring: Carbon Steel — Cadmium Plated or "410" Stainless Steel
Corrugated spring holds free floating ball on seat . . . compensates for wear . . . cuts maintenance

300 p.s.i. — W.O.G.

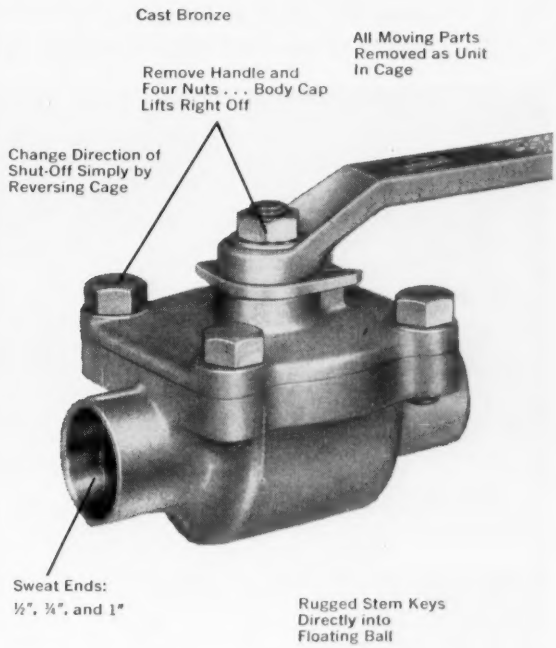
Sizes: ¼" thru 2"



Securely locked — cannot be accidentally opened or closed.

Serviced in minutes...

Top Entry Type


Cast Bronze
All Moving Parts Removed as Unit In Cage
Remove Handle and Four Nuts . . . Body Cap Lifts Right Off
Change Direction of Shut-Off Simply by Reversing Cage
Sweat Ends: ½", ¾", and 1"
Rugged Stem Keys Directly into Floating Ball

300 p.s.i. — W.O.G.

Sizes: ½", ¾", 1" and 2½"

Buna N Seals; Forged Hard Chrome Plated Ball; Beryllium Copper Spring; Buna N Seats (also available in Teflon, nylon, and Viton-A)

Whether it's positive security against accidental operation you're looking for or extra-easy servicing, you'll find the valve that fills your exact needs in the Rockwood line. And — you'll get all the Rockwood extra-performance features such as: ¼ turn opening and closing, 8-position lever operation, plus that smooth, full, round flow. Mail coupon for complete specifications.

Tested and listed by Underwriters' Laboratories, Inc.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

Distributors in all principal industrial areas

ROCKWOOD SPRINKLER COMPANY
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Worcester 5, Massachusetts

Please send details on ☐ Rockwood Snaplock Valves ☐ Rockwood Top Entry Valves.

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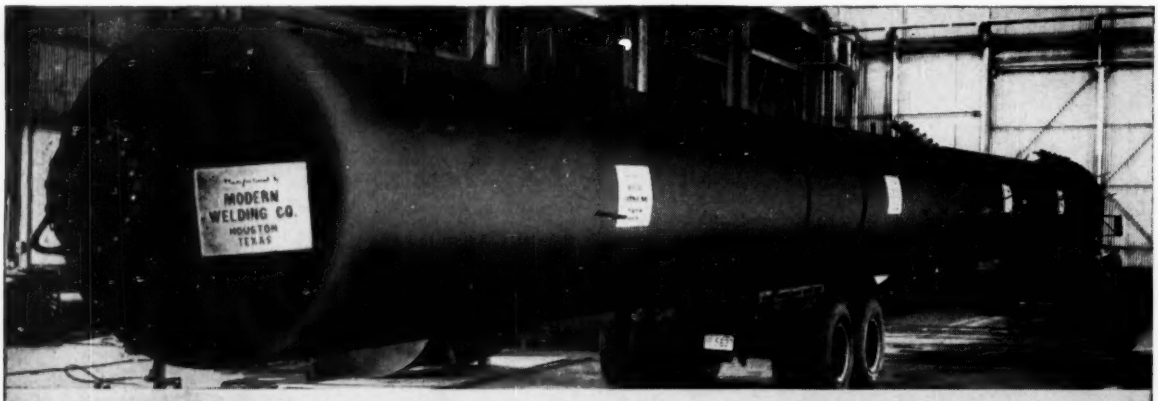
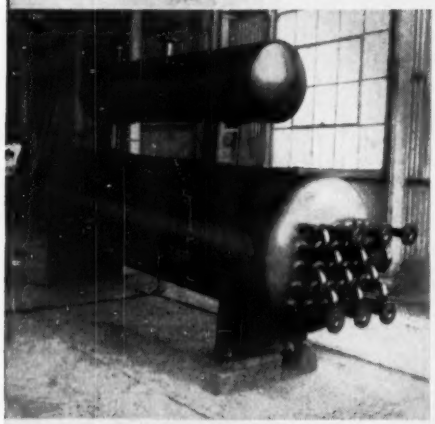
there is no substitute for *Experience*

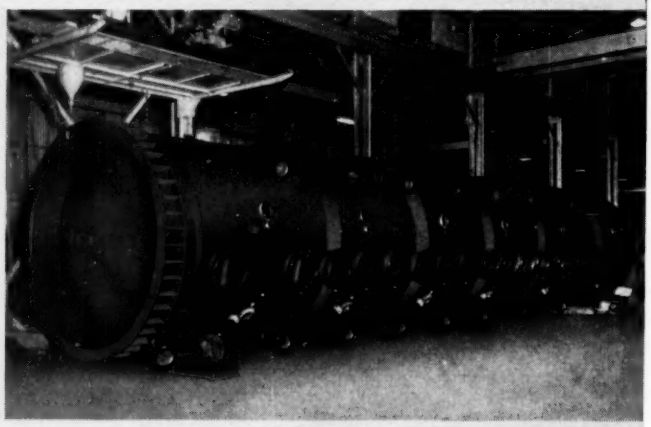
Modern Welding Company offers a wealth of experience in plate fabrication. Five well equipped Modern Welding Plants are strategically located to serve the Chemical Processing and Petroleum Industries. All plants are equipped to handle vessels that require exacting specifications.



Fractionating Column—72" Dia. X 110'-0" length, ¾" wall thickness with 40 trays. All welds 100% X-ray quality. Constructed for internal pressure and full vacuum. Stamped A.S.M.E. Code. Total weight 83,000 lbs.



Heat Exchanger — Lower Section 4'-0" dia. X 14'-0". Upper Section 1'-8" dia. X 10'-0", ⅝" Carbon Steel Plate Wall. A.S.M.E. Code construction using tube bundle of schedule 80 pipe.



Styrene Stripping Column—9'-6" Dia. X 80'-0" length, ½" plate walls and ⅝" heads. Constructed and stamped A.S.M.E. Code. Vessel contains 14 stainless steel perforated trays, 16 manways, 146 couplings, and nozzles. Total weight 72,000 lbs.

MODERN TANKS QUALITY

MODERN WELDING COMPANY

INCORPORATED

Owensboro, Kentucky

NEWARK, OHIO · ORLANDO, FLA. · HOUSTON, TEXAS · BURLINGTON, IOWA

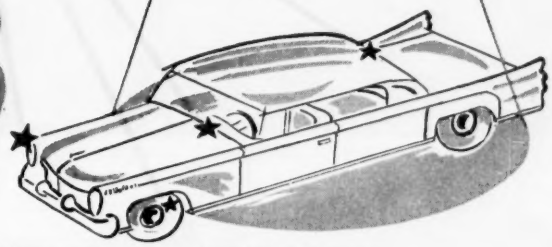
SULPHUR ONE OF THE FOUR STRONG PILLARS OF PROCESSING

INVISIBLE

BUT PRESENT

35 POUNDS OF SULPHUR

and derivatives help to produce the average automobile



Sulphur enters the automobile picture in two ways: directly and indirectly.

Sulphur, either as the elemental or as one or more derivatives, is used in the manufacture of rubber and rayon. Indirectly, it is used in processing the steel that forms the body. It is used in the plating operation on trim and fixtures. It is deliberately introduced into certain steels to provide better machining qualities.

Recognizing the importance of Sulphur to the basic industries such as the manufacture of automobiles, and to our ever-expanding economy generally, TGS is broadening its service: production, distribution and technical.

SULPHUR PRODUCING UNITS

• Newgulf, Texas • Spindletop, Texas
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TEXAS GULF SULPHUR CO.

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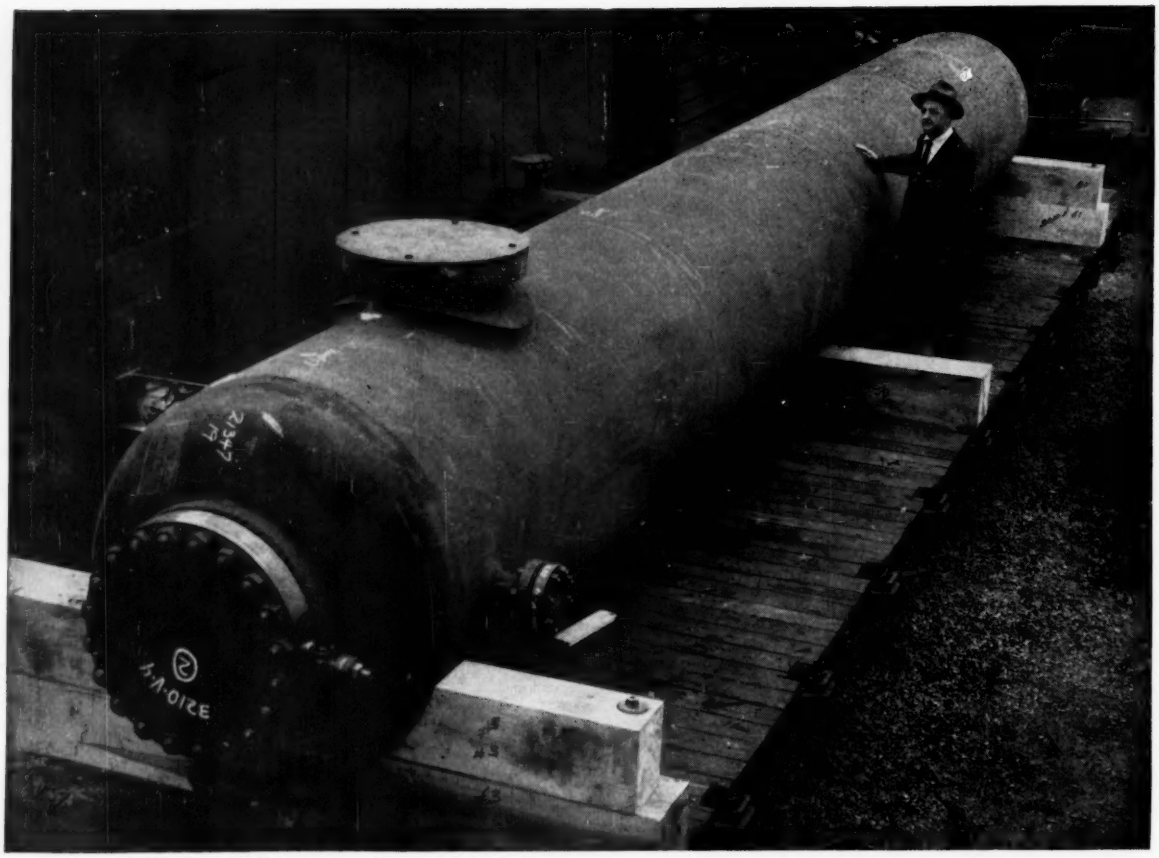


NEWPORT NEWS BUILT two 39'-7" horizontal gas scrubbers, such as this, for J. F. Pritchard & Co. They were made of ASTM-A212 Grade B fire box steel, with structural mesh steel interiors.

Gas scrubber made of 2⅞" steel

Newport News builds almost any type of pressure vessel and other heavy process equipment

Here is one of two horizontal gas scrubbers recently built for an operating pressure of 1800 psi at 300°F.

Newport News made both vessels from fire box steel, 2⅞ inches in thickness. We formed and automatically welded this steel into sections having a diameter of only 4 feet.

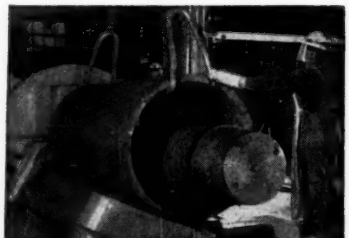
Rolling thick steel to this small diameter...no easy accomplishment, as you probably know . . . demonstrates the sort of jobs Newport News takes in stride.

Almost any type of heavy processing equipment is readily constructed by Newport News in a 225 acre plant comprising huge, fully equipped fabricating and machine shops, foundries, forge and die shops, heat treating and allied equipment as well as complete test facilities.

Newport News shop erection of fabricated units helps to speed assembly at your plant site.

Get a bid from Newport News on your present or future projects. Get the benefit of specialized production techniques. Look over the many ways in which Newport News can help you . . . write for "Facilities and Products", a very interesting booklet. It's yours for the asking.

ENGINEERS Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.



ROLLING 2⅞" STEEL for gas scrubbers. The steel, in a hot condition, was formed on the heavy bending equipment shown here. It will cold roll mild steel up to 3 inches thick, and will hot roll any grade of steel up to a thickness of 5 inches.

Newport News Shipbuilding and Dry Dock Company
Newport News, Virginia

Now you can predict service life because Byers PVC Pipe Engineering brings a factual approach to piping system design

FACT:

In sulfuric acid Byers PVC Pipe can out-perform stainless at 1/5 the cost

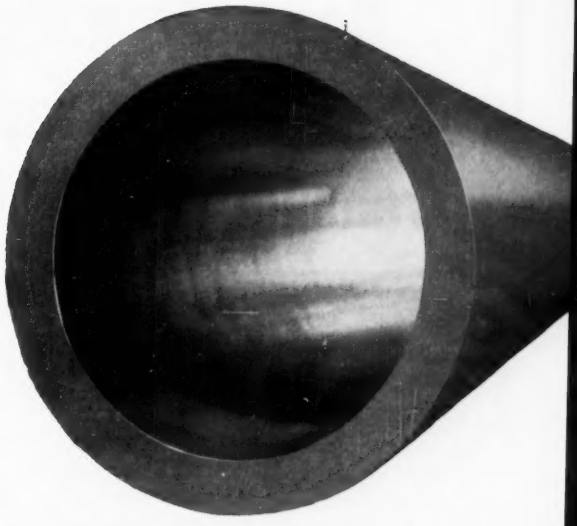
Stainless steel pipe often *fails* where Byers PVC Pipe *doesn't.*

Typical are sulfuric acid applications. Here, Byers PVC Pipe will not only out-perform stainless in terms of corrosion resistance — it also *costs less.* Only 1/5 the cost of stainless. That's why specification of Byers PVC Pipe makes such solid sense in this service.

The versatility of Byers PVC Pipe makes it ideal for many other corrosive services where metal pipe is either unsatisfactory or quite costly. Here are a few: acid fume vent piping, acid reactor blowoff lines, drain and sewer lines, and process lines handling acids, alkalies, oxidizing agents, alcohols, brines, plating solutions, slurries, and many other fluids.

Where product purity is important, Byers PVC Pipe is especially suitable. *It will not contaminate.*

A talk with a trained Byers field service representative can cut your corrosion bills, save you money. No obligation, ever. A. M. Byers Company, Clark Building, Pittsburgh 22, Pennsylvania.



Byers PVC Pipe is available in sizes ¼" through 6", in schedules 40, 80 and 120.

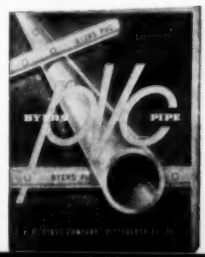
Type I — compounded of pure PVC resin for normal impact and outstanding corrosion resistance.

TYPE II — compounded of pure PVC resin to which has been added a modifier for high impact resistance in mechanically punishing applications.

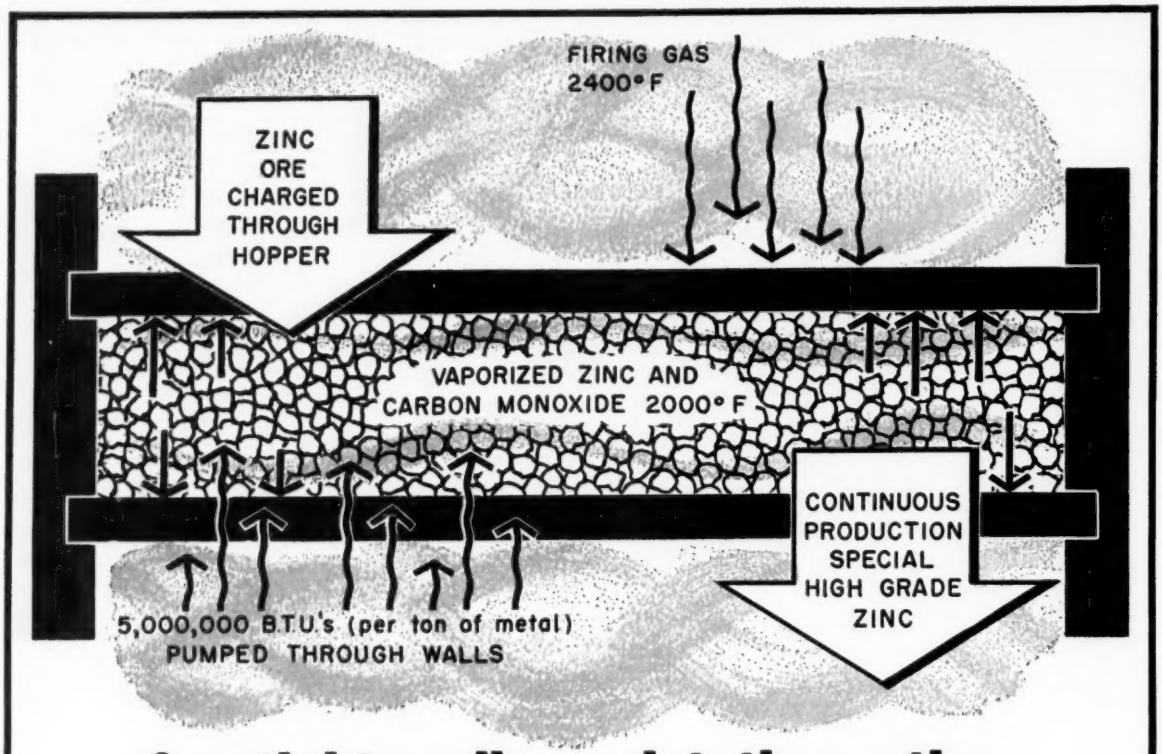
BYERS PVC PIPE

ALSO SHEET AND ROD STOCK

Write our Engineering Service Department for copy of new 32-page illustrated catalog on Byers PVC Pipe.



It was done with Carborundum's Super Refractories:



Gas-tight walls resist the action of zinc vapor and CO... transmit 5,000,000 BTU/ton of metal

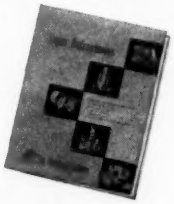
A combination of heat, pressure, wear and corrosion in New Jersey Zinc's vertical retort process for the continuous reduction of special high-grade zinc presented a difficult job for Super Refractories by Carborundum.

This process requires a structural material with high heat conductivity, low permeability to contain the gas-vapor mixture, and high strength at very high temperatures. It must also be chemically inert to the combusted gases outside and the reduction products inside the retort.

One of Carborundum's Super Refractories—CARBOFRAX® silicon carbide refractory—met these tough requirements. It has high thermal conductivity (11 times better than fire-clay), almost complete impermeability to gases (2 cu ft of cold air/hr/sq ft/inch of thickness, at 1" water pressure), exceptional load-bearing strength at high temperatures (300 psi at 2750° F without crushing). CARBOFRAX bricks are chemically inert, too (they resist most acids, acid sludges and fluxes, zinc oxide or vaporized zinc), and are highly resistant to abrasion (grinding wheels are made of silicon carbide).

If you have a problem that even the best of standard refractories or metals won't handle, consider Carborundum's Super Refractories. There is a wide range of products, each with a combination of properties seldom found in other materials.

Write today for your free copy of "Super Refractories by Carborundum." The address: Dept. H-39, Refractories Division, Perth Amboy, New Jersey.



CARBORUNDUM
Registered Trade Mark

When piping changes direction, protect process equipment with

ZALLEA SELF EQUALIZING UNIVERSAL EXPANSION JOINTS

Zallea Self Equalizing Universal Expansion Joints absorb any movement in any direction . . . axially, laterally, angularly, or any combination of these . . . making them ideal for protecting process vessels and rotating equipment from thermal expansion of connected piping.

When there is a leg or 90° offset to a long run of pipe, one Zallea Universal Expansion Joint will frequently take care of the entire system.

Under conditions of low load requirement for anchors or equipment . . . or when compressive loading in pipe walls must be kept to a minimum . . . Zallea Universal Expansion Joints are the most economical answer to the problem. They absorb the internal pressure thrust. The piping system need only carry the relatively small deflection loads.

Many types of Zallea Tied Expansion Joints are designed especially to absorb lateral deflection or rotation when there is pressure in the line. Universal, Modified Universal, Hinged, Gimbal, Pressure Balanced and Universal Pressure Balanced Expansion Joints give you a choice of the type best suited to your particular application.

Get the complete story of Zallea Expansion Joints in our new 72-page manual. Write, on your company letterhead, for your copy of Catalog 56. Zallea Brothers, 879 Locust Street, Wilmington 99, Delaware.

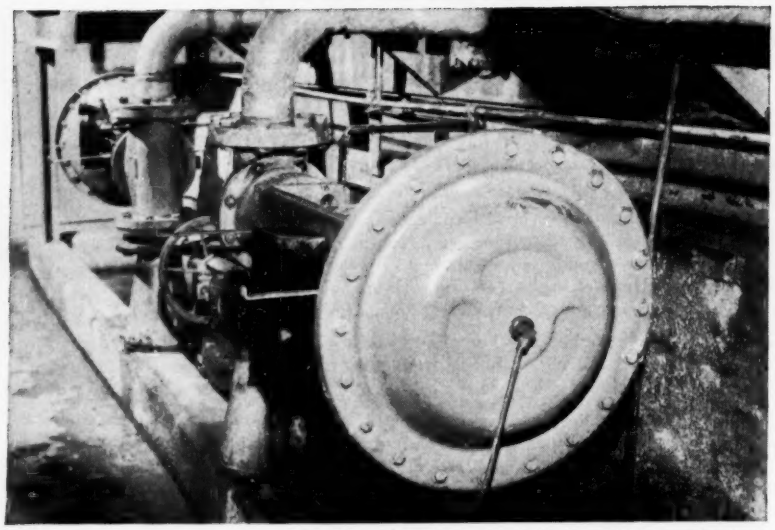
Zallea
expansion joints

Zallea Brothers • Wilmington 99, Delaware

World's largest manufacturer of expansion joints

24" dia. Zallea Universal Self Equalizing Expansion Joints in service lines of the engine test facility of a West Coast aircraft manufacturer.

Found:
a valve responsive to sensitive instrument control, with low maintenance



Grinnell-Saunders Straightway Diaphragm Valves on back of Trimbey meter on Mead Corporation's No. 10 paper machine.

Grinnell-Saunders Straightway* Diaphragm Valves were originally selected by Mead Corporation for stock level control at its Chillicothe, Ohio paper making plant. Mead's instrumentation specialists wanted a valve which would provide fine control in response to sensitive instruments.

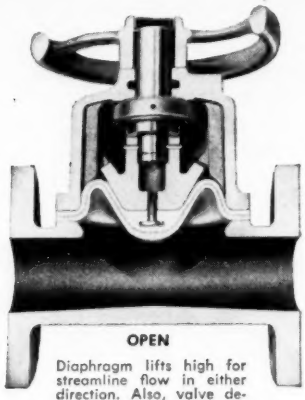
Because these Straightway Valves also avoid difficulties from clogging, stringing and dewatering as well as leakage, plugging, sticking and erosion, they have since been specified for other services throughout the plant.

Grinnell-Saunders Straightway Diaphragm Valves solve tough problems in many piping systems. They provide special benefits in lines handling corrosive fluids, viscous material, fibrous slurries, sludges, solids in suspension and semi-fluid materials.

These highly efficient valves provide streamlined flow, positive closure, complete isolation of operating mechanism, minimum maintenance, interchangeability of parts, manual or power operation, and a choice of body lining and diaphragm materials.

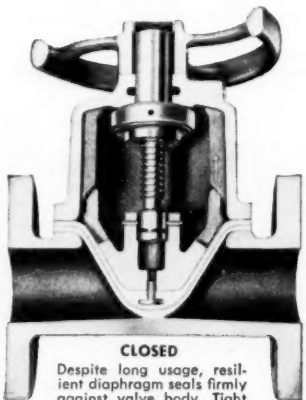
For complete information on straightway or standard weir types, handwheel, lever, or power operated, write Grinnell Company, Inc., 277 West Exchange Street, Providence 1, Rhode Island.

*PATENTED



OPEN

Diaphragm lifts high for streamline flow in either direction. Also, valve design permits comparatively simple rodding through, when necessary.



CLOSED

Despite long usage, resilient diaphragm seals firmly against valve body. Tight closure is assured, even when handling gritty or fibrous materials.

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pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
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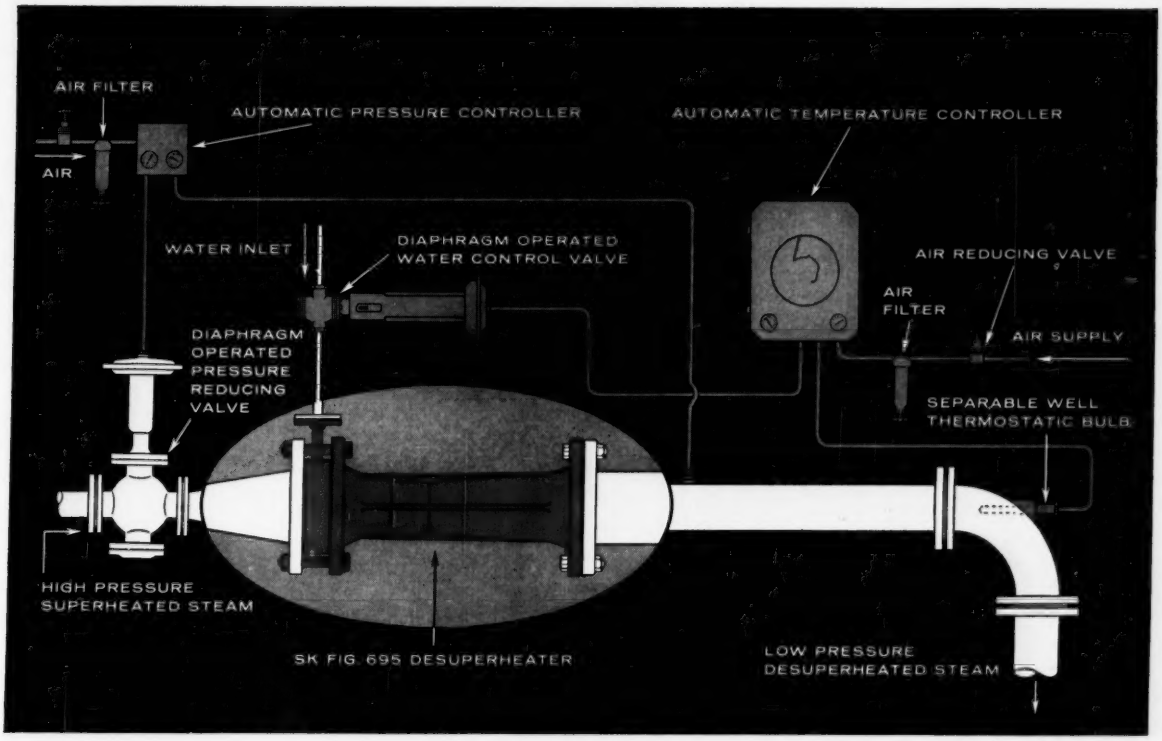
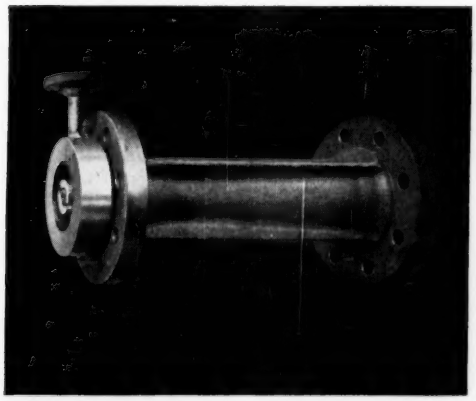


Reduce Steam Temperature for Process Operations

with this light, easily-controlled Desuperheater

SK Fig. 695 Venturi Type Desuperheater. An important feature of this desuperheater is the fact that the water need not be at higher pressure than the steam entering the desuperheater. As noted in description, right, water can enter the unit at inlet steam pressure.



The SK Venturi Type Desuperheater, shown in the illustrations above and at left, is designed to reduce the temperature of superheated steam to the lower temperatures required for use in process operations and for operating plant auxiliaries.

These Desuperheaters are light in weight and small in dimensions—are supported directly by the superheated steam line. In addition, they are simple in construction, provide straight-through flow with only a small pressure drop. Because these units are designed for application with automatic control, they are particularly well suited for process and petroleum plants where steam flow varies. They can, however, be used without controls where steam flow is steady. In such cases only a separator need be added.

The Venturi Type Desuperheater reduces steam temperature by bringing water into contact with the superheated steam. The water pressure is low since it need only equal the operating steam pressure. The water is preheated in the chamber around the water diffuser and issues, through many small jets, into the steam stream. Since the steam-water mixture is discharged through the desuperheater outlet in a fog-like condition, without contacting the sidewalls, maximum desuperheating effectiveness is obtained and minimum wear occurs in the discharge piping.

The particular desuperheater shown is one of four types made by SK for process plants. Complete details on all types are contained in Bulletin 6D. Write for a copy.

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
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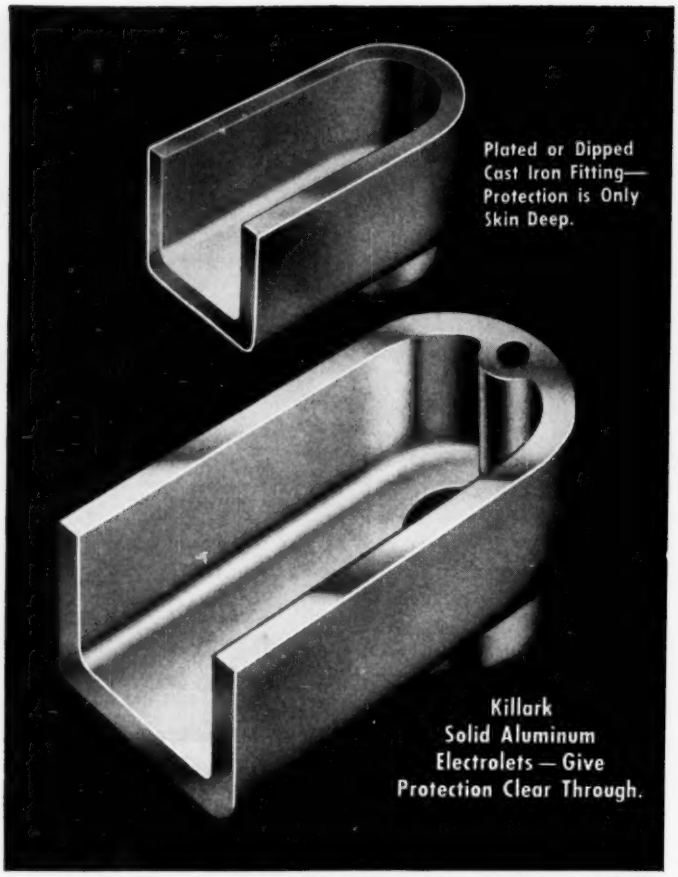
MANUFACTURING ENGINEERS SINCE 1876
2217 State Road, Cornwells Heights, Bucks County, Pa.

for Quality that goes more than skin deep...

INSIST ON Killark ALUMINUM CONDUIT FITTINGS


Plated or Dipped Cast Iron Fitting—Protection is Only Skin Deep.
Killark Solid Aluminum Electrolets — Give Protection Clear Through.

Weatherability and durability are cast right into every Killark Electrolet—not just on the surface.

You can specify with complete confidence, because Killark Electrolets are designed for extra strength at points of stress, and made of an alloy that scientifically balances lightweightness with strength.

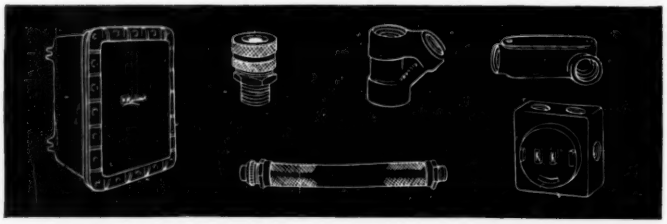
Killark manufactures a complete line of UL and CSA approved Explosion-Proof, Vapor-Proof and Dust-Tight fittings and fixtures.

Write for the Killark Catalog of Electrical Fittings and Fixtures

the cross section tells the story

The slice across the cast iron fitting above quickly shows you why a coating or plating is only temporary protection at best. Regardless of how well and how carefully applied, this surface requires only the slightest scratch or nick to open the door to expensive rust and corrosion.

The Killark Electrolet is solid aluminum, alloyed with other metals to give strength and ductility . . . it can't ever rust and has much more resistance to corrosion.



Killark ELECTRIC MANUFACTURING CO.
Vandeventer and Easton Aves. St. Louis 13, Mo.

IS YOUR FILE UP TO DATE?

If you use any of these chemicals, you'll want Allied's latest technical, price and delivery information on them. To get it, just call or write your nearest Nitrogen Division branch office. Or simply check right on this ad the materials of interest to you, clip it to your letterhead and mail to Nitrogen Division's New York headquarters.

ANHYDROUS AMMONIA — This basic industrial chemical is available in commercial and refrigeration grades from three strategically located plants.

AQUA AMMONIA (NH_4OH) — An economical source of nitrogen and an easily handled alkali.

AMMONIUM NITRATE — In pelleted form. Typical analysis: Ammonium Nitrate content — 96% or more.

AMMONIUM SULFATE — Diverse uses include fireproofing, fertilizers, leather tanning.

NFS-83 and NFS-50—Ammonium nitrate-water solutions containing respectively 83% and 50% NH_4NO_3. For explosives, fluid catalysts, pharmaceutical applications.

ETHYLENE OXIDE — Rocket propellant, fumigant, fungicide, chemical intermediate.

ETHYLENE GLYCOL — Also DI- and TRI-. Humectants, plasticizers, scrubbing solutions for gas dehydration, scores of other industrial uses.

ETHANOLAMINES—MEA, DEA and TEA. Versatile, reactive, easy to handle. TEA available in 98% and commercial grades.

FORMALDEHYDE — Available as 37% Inhibited, 37% Low-Methanol, 45% Low-Methanol, 50% Low-Methanol.

METHANOL — In barge, tank car and tank truck quantities, all 99.85% pure.

NITROGEN TETROXIDE—High energy oxidant for liquid rocket propellants. Easy to handle and store.

SODIUM NITRATE — Three grades — coarse, medium, fine — to meet exacting process requirements. 99.5% pure.

UREA — Multiplant production assures unfailing supply of this basic chemical in crystal and pelleted form.

U-F CONCENTRATE-85 — Highly concentrated solution of urea (25%) and formaldehyde (60%). Easy to handle, economical source of these materials for resins and adhesives.

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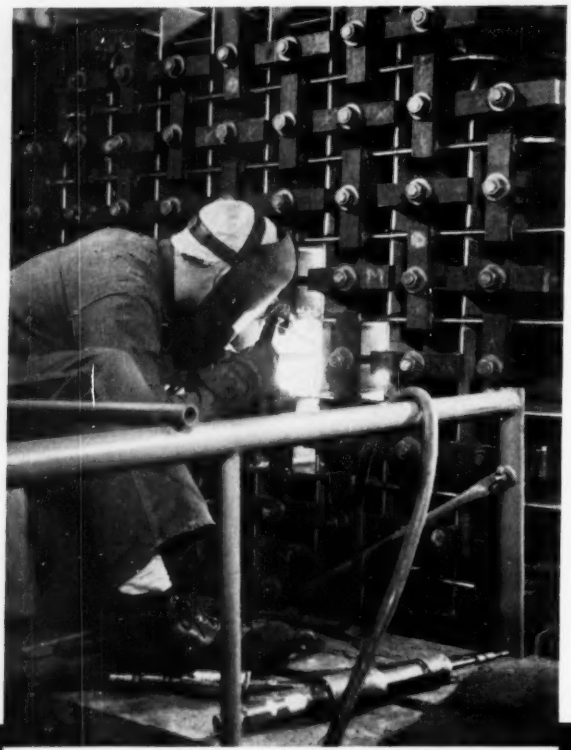
Basic To America's Progress

Allied Chemical

Reactor core supports of steel, signal bridges of aluminum . . . evidence of B-L-H scope and skill in fabrication



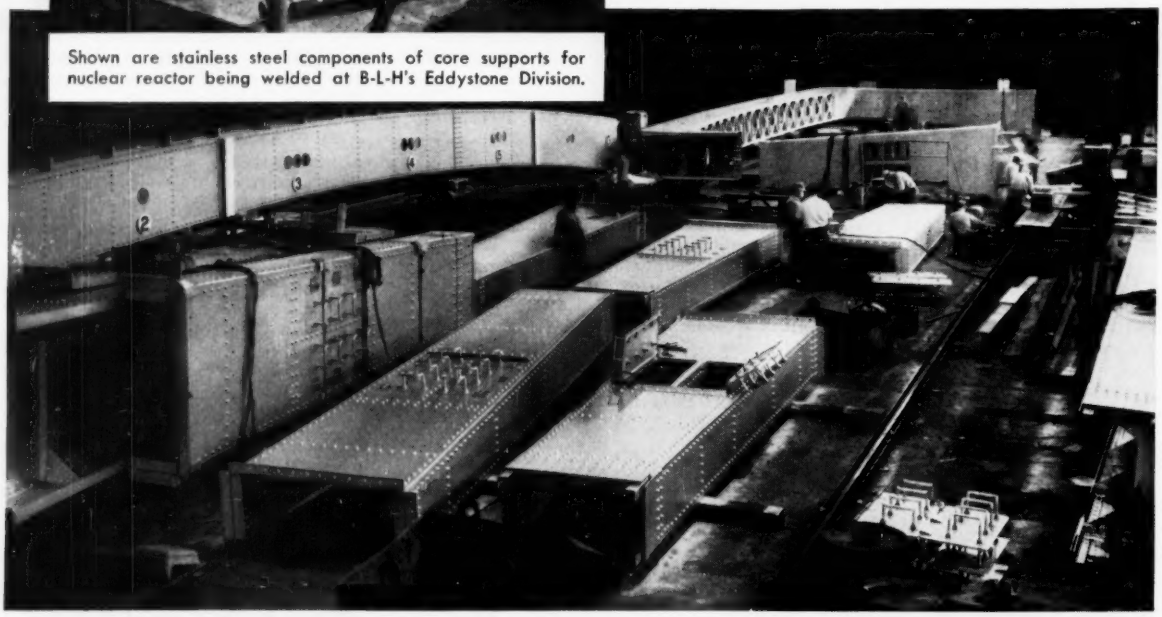
Traffic signal bridges or nuclear reactor core supports, 100-ton pressure vessels or a hub and shaft assembly for a wind tunnel—no matter how big or unusual or complex the fabricating job, whether ferrous or nonferrous metals, B-L-H's Eddystone Division can handle it—economically, swiftly, expertly.

The signal bridges (see illustration) were constructed of structural aluminum sections, plates and bars in conformance with the strictest specifications. There are 15 of these structures, and they are 84 feet long. In Eddystone's huge shop—13 bays, each 900 ft. long—handling these giants presented no problem.

The nuclear reactor core supports, fabricated of stainless steel, called for rolling, welding, stress-relieving, and extremely accurate machining. In spite of the close tolerances required, expert planning and accurate manufacturing permitted final assembly of the core and core components with ease and a minimum of selective preassembly.

Write us for a free copy of our illustrated Weldment Bulletin 7001. It will give you an excellent idea of the broad scope of our work.

Shown are stainless steel components of core supports for nuclear reactor being welded at B-L-H's Eddystone Division.



Components of traffic signal bridges for Delaware River Turnpike Bridge in vast fabricating shop at Eddystone.

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Eddystone Division

Philadelphia 42, Pa.

Hydraulic turbines • Weldments • Dump cars • Nonferrous castings • Special machinery • Bending rolls • Machine tools

. . . another exclusive development from FALLS (FI) INDUSTRIES . . . the almost perfect heat exchanger

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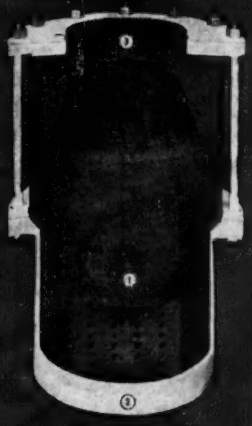
CROSS-BORE HEAT EXCHANGER



The CROSS-BORE exchanger is composed of only three parts: (1) "one-piece" heat transfer cylinder, drilled longitudinally and laterally to permit passage of the two fluids or gases, (2) shell, and (3) domes. CROSS-BORE exchangers have been proving their unique value in field service for over 4 years.

. . . unaffected by all corrosives except a few highly oxidizing agents . . . strongest, shock resistant construction available in any impervious graphite exchanger . . . 20% higher overall heat transfer coefficient than tube and shell design . . . provides new ease for thorough cleaning of shell side as well as tube side holes . . . immune to thermal shock . . . results in longer service life . . . accommodates pressures in the 150-200 psi range at temperatures to 340°F . . . overall dimensions same as tube and shell design . . . available in capacities to 470 sq. ft. heat transfer surface.

Write today for quotation on your heat transfer requirements...start enjoying the profits and efficiency of maintenance-free, corrosion-proof heat transfer equipment.

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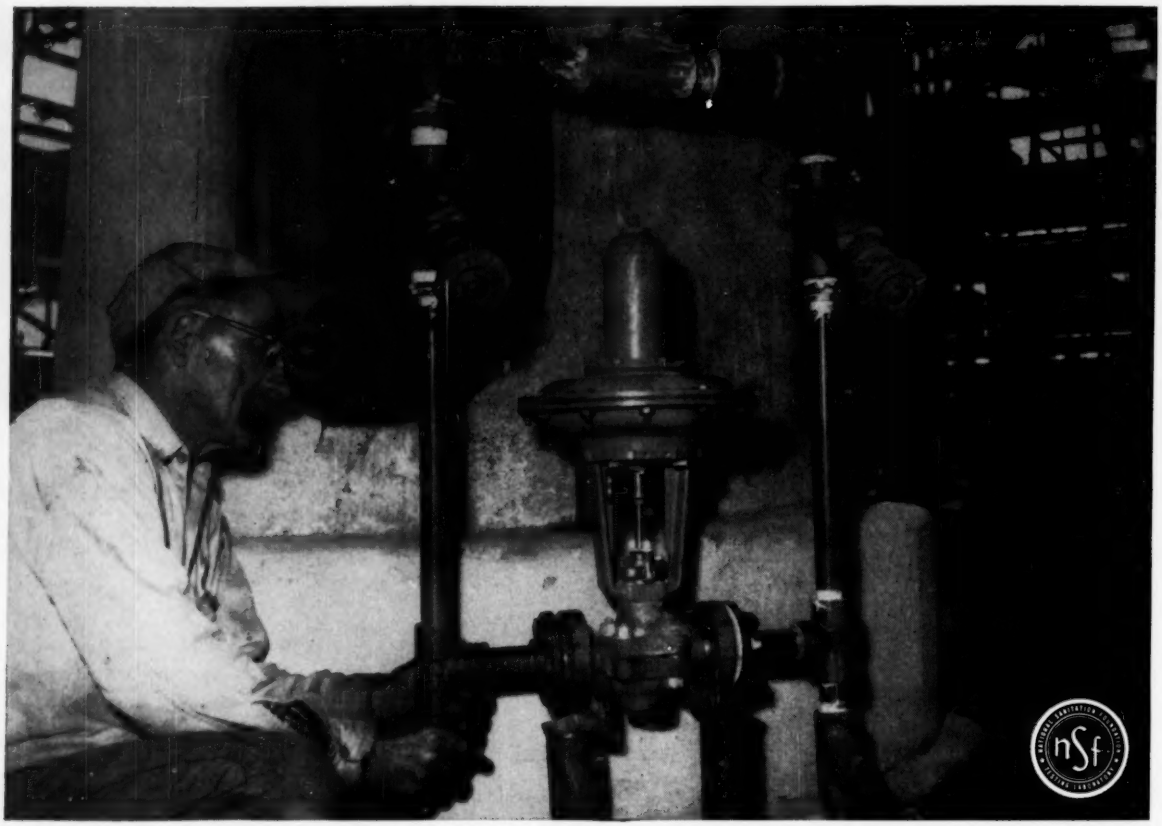


Texaco Chemical Plant uses acid lines of USS National* PVC Pipe

A lube oil additive plant, recently constructed by Texaco at its Port Arthur, Texas refinery, employs 750 feet of normal-impact National Polyvinyl Chloride Pipe (Schedule 80). Over 500 feet of this PVC Pipe, in diameters of 1 inch and 1½ inches, is being used to handle a variety of mineral and organic acids involved in the lubricating oil additive production process.

Other National PVC Pipe, in diameters of 2 inches, 3 inches and 4 inches, carries waste water at 120°F from the glass-lined neutralizing tank. This water also contains acids and other by-products of the process. Additional smaller diameter lines of National PVC Pipe are employed as treating tower return lines, operating at ambient at 40 to 50 psi.

Tough, rigid, acid-resistant National PVC Pipe is available in sizes up to 14″ O.D. and in Schedules A, 40, 80 and 120. It comes in two types:

Normal impact – for installations requiring the highest chemical resistance attainable, together with high strength and excellent creep resistance.

High impact–for installations requiring excellent chemical resistance and a high degree of toughness, even at low temperatures.

For further details, write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pennsylvania. Ask for Bulletin No. 24.

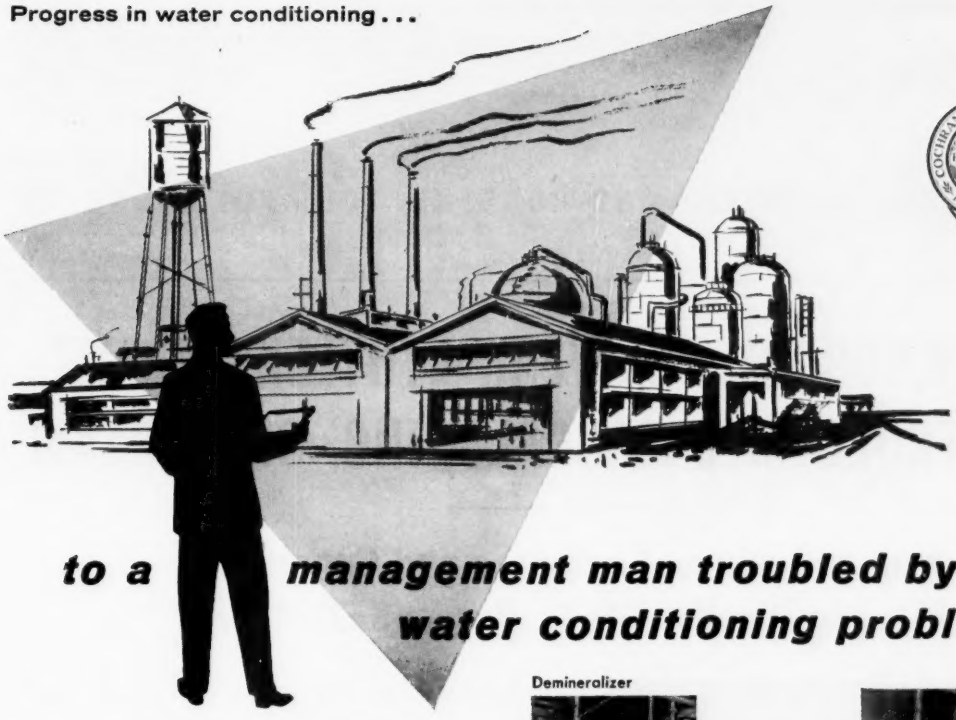
**Trademark*

The world's finest tubular products from the best-known name in pipe—National Tube.

National Tube Division of USS United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • United States Steel Export Company, New York

Progress in water conditioning . . .



to a management man troubled by water conditioning problems . . .

Is your plant's water treatment system overloaded by new boilers, turbines or process equipment? Can your product be improved or made more uniform by higher quality water? Sometimes the only answer is to install a complete new system, but in many industrial plants Cochrane has been able to find far less costly solutions utilizing present equipment.

Cochrane is in a unique position to assist your staff in analyzing all approaches to your problem and selecting the most economical one. Its experience in water and heat engineering covers nearly a century and every industry from steel to pharmaceuticals and atomic power. Cochrane manufactures all types of water treatment equipment, assuring you of an unbiased recommendation. A Cochrane representative will be glad to discuss your problem with you or your staff. There is no obligation, simply call or write: Water Treatment Division.

Cochrane CORPORATION

3113 N. 17th Street, Philadelphia 32, Pa.

Philadelphia • New York • Chicago

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Representatives in thirty-two principal cities in U.S., Hawaii, Puerto Rico; also Havana, Cuba; Paris, France; La Spezia, Italy; Mexico City, Mexico; Caracas, Venezuela; Santiago, Chile; Manila, Philippine Islands.

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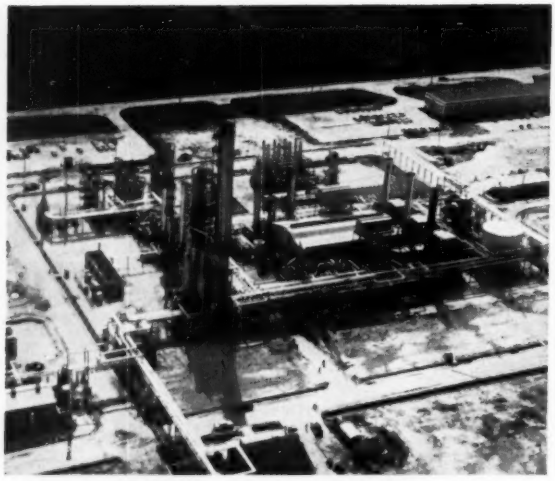
200,000,000 LB. PER YEAR ETHYLENE PLANT FOR PETROLEUM CHEMICALS, INC. ON STREAM

Lummus Designs, Engineers and Constructs Plant to Pipeline 99.7+ Percent Ethylene



Petroleum Chemicals, Inc. new ethylene plant at Lake Charles, Louisiana is now on stream. Initial ethylene product capacity is 600,000 lbs/per day but Lummus has designed the plant for rapid expansion to a rate of 900,000 lbs/per day. Ethylene will be produced in two grades – the highest grade is 99.7% assay and the other grade 98%. Co-products will be high assay propylene, a butane-butylene fraction and aromatic distillate. Operations have been marked by continuous production of specification high assay ethylene under widely varying rates and feed stock compositions.

The plant incorporates a new ethylene separation process developed by The Lummus Company which provides high separation efficiencies and unusual flexibility and reliability. Feed gases for the ethylene plant are provided from three sources; the nearby refineries of Cities Service and Continental Oil – by whom P.C.I. is jointly owned – and P.C.I.'s new ammonia plant. P.C.I.'s high assay ethylene is delivered via pipeline to customers at Orange, Texas. Part of the new plant's output feeds the adjacent Calcasieu Chemical Corporation's new ethylene oxide and glycol plant, also engineered and constructed by Lummus.

Ethylene is used in the manufacture of polyethylene plastics, anti-freezes, synthetic rubber products, tetraethyl lead and liquid detergents.

Cracking section of the plant features an improved Lummus heater which embodies years of research and development by Lummus' Oil Heater Division.

All major compressors in the Lummus designed low temperature fractionation unit are driven by three 12,500 HP gas turbines. Gas turbine exhaust serves as preheated air for three high pressure steam generators. High efficiency expanders provide low temperatures for maximum ethylene recovery.

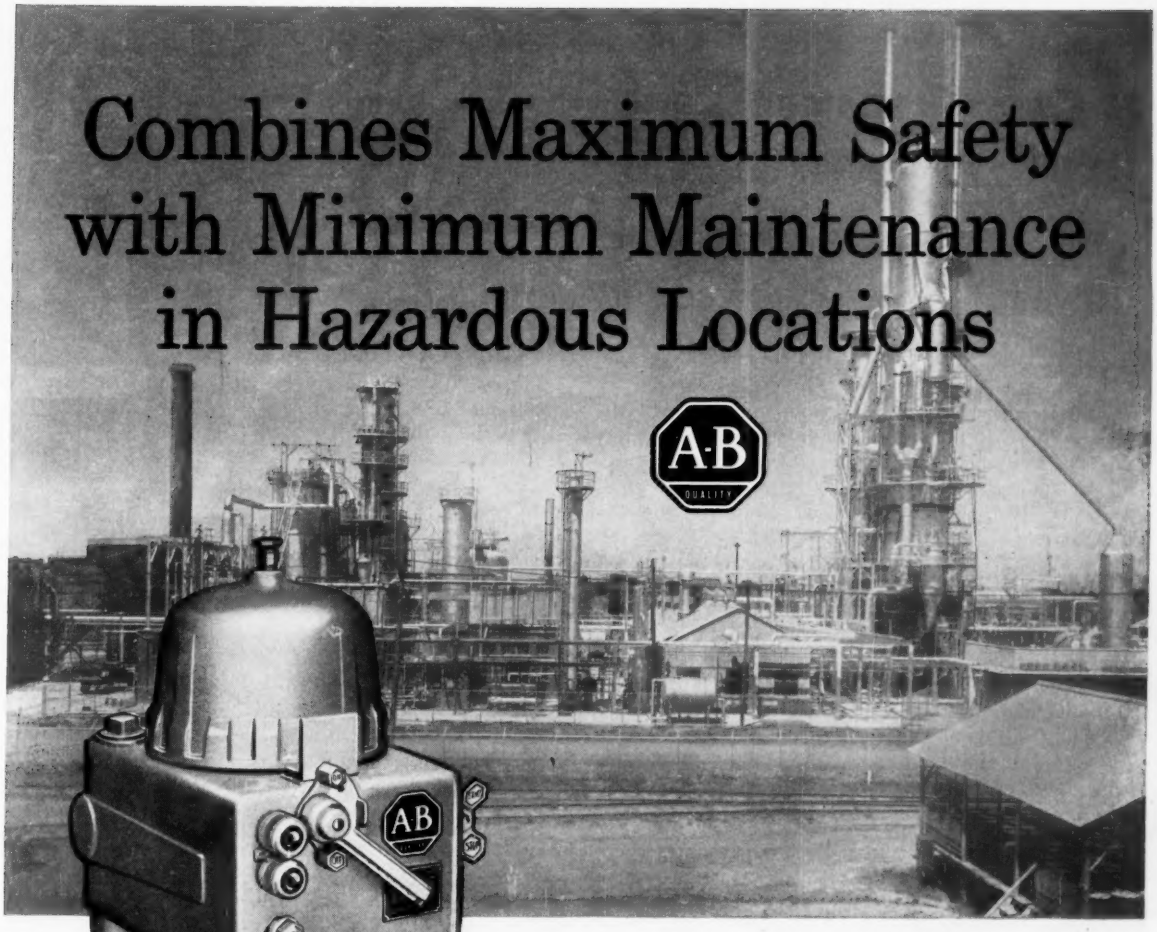
This plant brings the total of Lummus designed ethylene plants to 14, with a combined capacity of over 1 billion pounds per year.

Lummus has designed, engineered and constructed over 800 plants for the process industries throughout the world in the last 50 years. Why not discuss your next project with a Lummus representative.

THE LUMMUS COMPANY, 385 Madison Avenue, New York 17, N. Y., Houston, Washington, D. C., Montreal, London, Paris, The Hague, Maracaibo. *Engineering Development Center:* Newark, N. J

Visit the Lummus Exhibit, Fifth World Petroleum Congress Exposition, New York Coliseum, June 1-5, 1959

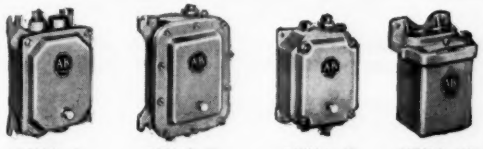
Combines Maximum Safety with Minimum Maintenance in Hazardous Locations



Bulletin 713 combination starter in Crouse-Hinds screw type enclosure for hazardous gas and hazardous dust locations. Screw type covers permit quick access to starter or disconnect switch.

When safety regulations require special enclosures for your motor control, inspection and maintenance costs can become an important consideration. With Allen-Bradley starters you can practically eliminate these expenses because these starters operate over long periods of time—without attention.

The reason is simple. Allen-Bradley solenoid starters have only *one* moving part. There's virtually nothing to go wrong. This is your assurance of millions of trouble free operations. And, the double break, silver alloy contacts never require servicing — they remain in perfect operating condition until completely worn away. Inspection only once or twice a year is ample. And, with the spin-type NEMA 7 and 9 enclosures, inspection is greatly simplified. Combine maximum safety with minimum maintenance — specify Allen-Bradley *quality* motor control in all your hazardous locations.



NEMA 4 Watertight Weatherproof

NEMA 7 For Hazardous Gas Locations

NEMA 9 For Hazardous Dust Locations

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ALLEN-BRADLEY
MOTOR CONTROL
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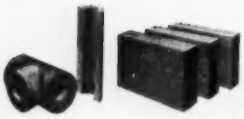


FOAMGLAS® INSULATION / waterproof, vapor-proof, strong, can't burn, acid-proof, vermin-proof, dimensionally stable

AT ROHM & HAAS CO.—

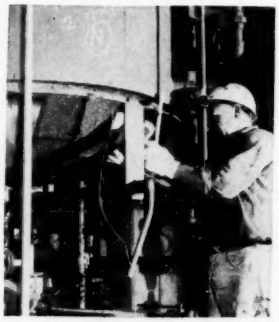
10 year maintenance-free service record backs choice of **FOAMGLAS®** insulation here

Ten years ago, Rohm & Haas Company picked FOAMGLAS to insulate all piping and equipment in a huge new industrial chemicals plant the company built in Deer Park, Texas. Since that time, they've had virtually no insulation maintenance—and the insulation serves as effectively today as when it was installed.

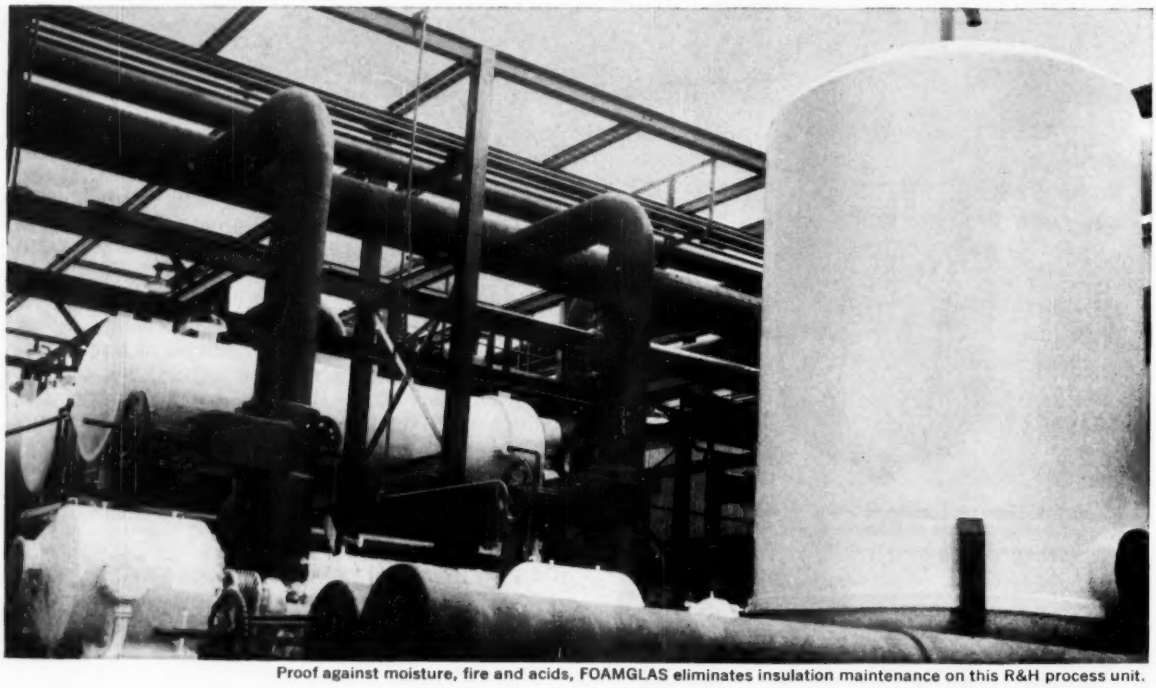
That service record led R & H to pick FOAMGLAS to insulate all piping and equipment for the Deer Park plant's new low temperature processing unit (pictured below).

What makes FOAMGLAS such an effective industrial insulation? This unmatched combination of benefits: FOAMGLAS seals out all moisture to insure insulating efficiency that cannot vary. It is acid-proof. It can't burn. It's quick and easy to install and needs little or no maintenance.

Next time you face the problem of insulating piping or equipment, let Rohm & Haas' experience be your guide. Pick FOAMGLAS. Complete information on this unique cellular glass insulation is contained in our new industrial insulation brochure. To get your free copy, write Pittsburgh Corning Corporation, Dept. H-39, One Gateway Center, Pittsburgh 22, Pennsylvania. In Canada: 3333 Cavendish Blvd., Montreal, Quebec.

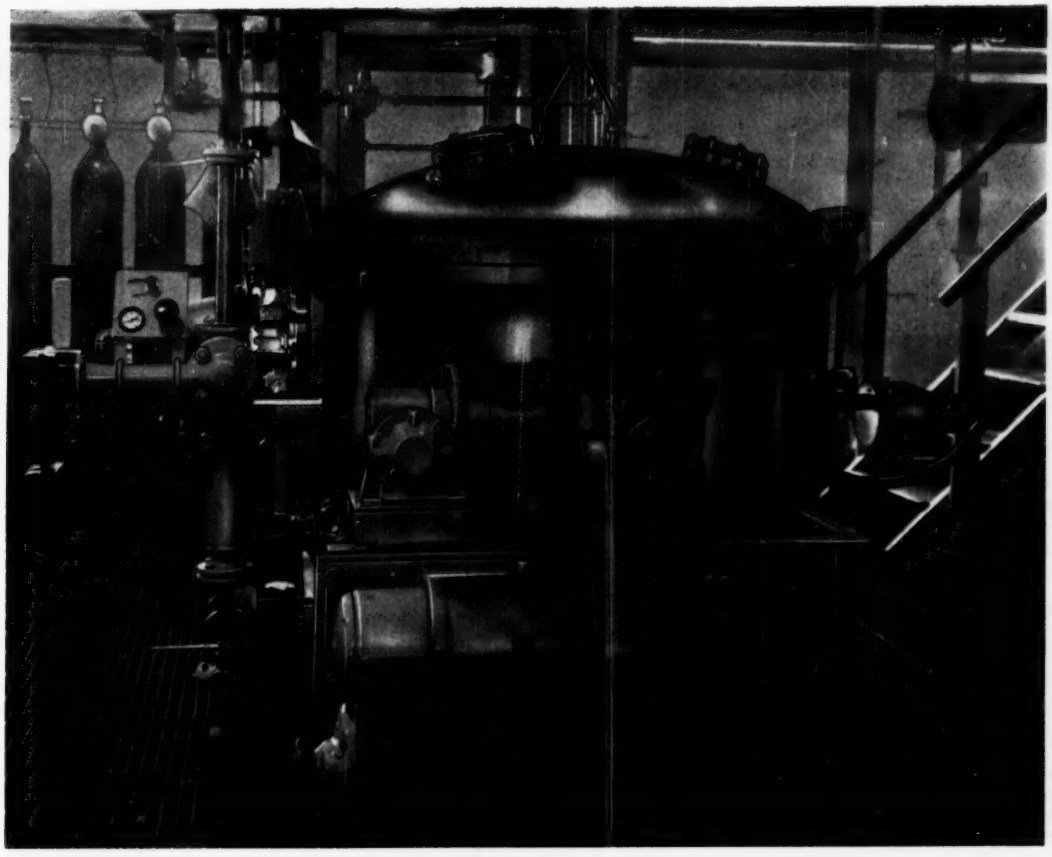


Lightweight, easy to cut and shape, FOAMGLAS saved installation time and money for Rohm & Haas. Installation by the Aber Company.



Proof against moisture, fire and acids, FOAMGLAS eliminates insulation maintenance on this R&H process unit.

PITTSBURGH PC CORNING



For The Upjohn Company...

CUSTOM-BUILT solution

for a filtration problem

This FEinc rotary pressure filter was designed and built recently to specifications of The Upjohn Company, Kalamazoo, Michigan. It separates organic crystals from a solvent slurry at pressures up to 30 p.s.i.

The design of this new rotary pressure scraper filter represents another achievement for Filtration Engineers in the design of filters for special applications.

If you have a problem in solvent processing . . . or any other filtration problem . . . contact Filtration Engineers for specific recommendations which are available without obligation.

Your individual requirements determine the type of filter needed, its size, construction materials and the special features necessary for highest efficiency. For more complete data, see FEinc's section in Chemical Engineering Catalog or write Dept. CEF-359.

For a Bigger Yield

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SPECIALISTS IN LIQUID-SOLIDS SEPARATION

RODNEY HUNT

FLUID PROCESSING

RODNEY HUNT MACHINE CO., Process Equipment Division, 31 Vale Street, Orange, Mass.

RODNEY HUNT THIN-FILM TECHNIQUE SOLVES COMPLEX PROCESSING PROBLEMS

Manufacturers of chemicals, foods, pharmaceuticals and many other products have discovered in the Rodney Hunt mechanically aided thin-film processors a simplified solution to complex processing problems. Whether the process involves concentration, dehydration, heat transfer, stripping, deodorization, evaporation or reaction, these units assure closely controlled uniformity of product. They have proved to be particularly effective in processing time-at-temperature-sensitive materials because of short time exposure and minimum hold-up of fluids in the thermal section. The process is completed in one pass, continuously and rapidly, thereby eliminating the problems and downtime of conventional batch processing. Formation of crust or scale is minimized permitting operation for long periods of time without shutdown.

Broad Operating Range

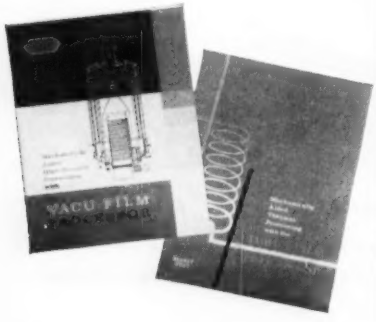
For processing at atmosphere and low vacuum ranges, Rodney Hunt offers the well known Mark II Turba-Film Processor. The new Vacu-Film Processor is designed for thin-film processing at high vacuum . . . to one-half micron. Installations of this new unit have resulted in higher and purer yields than ever before possible and have greatly simplified the thermal problem associated with high molecular weight materials. It has successfully isolated and purified complex pharmaceuticals which had been impossible to produce by conventional techniques.

Simplify Your Process

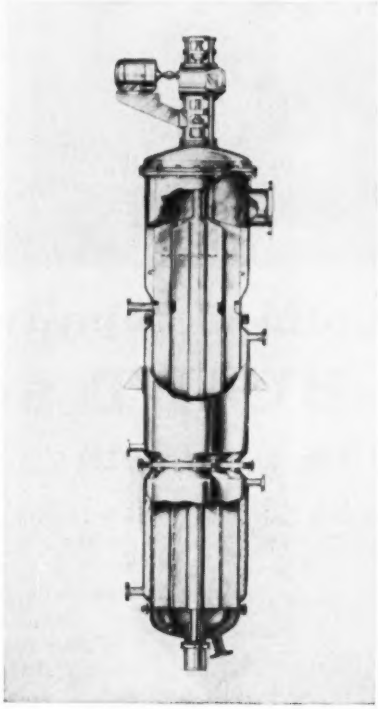
Rodney Hunt welcomes your specific requests for assistance in solving the most complex and unusual processing problems. A fully equipped laboratory and pilot plant staffed by experienced process engineers and technicians is available to work with you on your problem. Test results obtained from pilot size Turba-Film and Vacu-Film Processors can be readily extrapolated to production size units. If you prefer to do your own testing, portable units are available for purchase or rental.

Address your inquiry to the Rodney Hunt Process Equipment Division, 31 Vale Street, Orange, Mass. with details of your requirements. Detailed literature on the Turba-Film Processor and Vacu-Film Processor will be sent on request.

* * *



Turba-Film Processor



MECHANICALLY AIDED THERMAL PROCESSING

The Turba-Film Processor consists of a series of rotor blades operating within a thermal section and a separating section—all fabricated of alloy steel. Clearance between the rotor blade edges and the thermal section wall is exactly fixed to assure precise control of the film thickness. Vapor or gases pass upward through the thermal section to the separator from which entrained material is recycled to the thermal section. Steam, Dowtherm or other heating media is distributed in two or more compartments of the thermal section to assure a uniform temperature at the walls.

This New Inexpensive Lab Unit Opens Up New Areas In R & D

For the first time you can explore the whole field of mechanically aided high-vacuum processing at relatively low cost. The Rodney Hunt Laboratory Vacu-Film Processor is simple to operate . . . inexpensive to buy. It makes possible the development of data in evaluating the application of high-vacuum techniques to a specific process in a commercial-size unit.

It operates in a vacuum range from atmospheric to 1 micron Hg. at temperatures to 450°C. Continuous feed or batches from 10 ml to 20 litres. Temperature, product flow and rotor speed are easily regulated and controlled. Two or more units may be coupled for fractionation. All parts are readily accessible and can be quickly cleaned like laboratory glassware.

Many Areas of Application

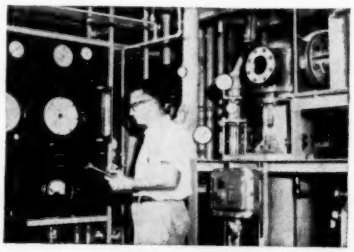
From isolation of essences and removal of odors and color bodies to purification of pharmaceuticals and distillation of fatty acids, the Rodney Hunt Laboratory Vacu-Film Processor uncovers many new applications of great profit potential.

Standard units (illustrated above) are now available for immediate shipment.

Price FOB Orange, Mass.—$393.00

Descriptive Bulletin PE-108 sent on request.

Turba-Film Processor Solves Product Discoloration and Boosts Drug Yield



Abbott Laboratories encountered product discoloration and loss of product prior to placing the bacteria-killing drug ristocetin into full production. This problem was solved by replacing conventional evaporator with a Rodney Hunt Turba-Film Processor designed to handle the heat-sensitive product. The Turba-Film Processor helps turn out a uniform top-quality pharmaceutical product.

DEVELOPMENTS . . .

MARCH 23, 1959

Chementator

C. H. CHILTON

Indiana Standard's process for making high-density polyethylene will go commercial by midyear when Japanese licensee Furukawa Chemical starts up its new plant.

Can you use woven cloth made of graphite? That's National Carbon's latest research baby. Suggested applications include the missile field.

Sea water distillation pilot plant being furnished Southern California Edison by Cleaver-Brooks uses "new principle" in flash evaporation equipment. Reluctant with details, CB explains that certain design innovations achieve major reduction in first cost and permit use of available sources of waste heat.

Expanding mortar lengthens brick life

Prestressed brick lining of steel vessels—a construction technique widely used in Europe—is now gaining a foothold in this country. A number of U. S. companies—including Frontier Chemical, Toms River Chemical and Standard of California—are reported to be testing its virtues.

A prestressed-brick-lined carbon steel reaction tower, 50 ft. high, has already given one of these chemical firms three trouble-free years of service, with many more in view. This vessel, at an installed cost of $63,000, replaced a $95,000 alloy tower which had a useful life, under the severely corrosive operating conditions, of only two years.

Key to this lining system is a special corrosion-resistant mortar which permanently expands when heated. The lining is laid cold, then the entire vessel is heated to above its operating temperature. As the steel shell expands, the lining swells to fill the void, but it does not shrink when the vessel is cooled. The lining is thereby put under compressive stresses which prevent any later cleavages in brick structure or separation from the shell.

Mortar was developed in Germany by Farbwerke Hoechst. Pennsalt Chemical Co., Philadelphia, began making it early this year under license. Exact compositions are secret, but one mortar for relatively low-temperature duty is said to contain a thermosetting resin with a special plasticizer.

Europe's acceptance of the technique of prestressed brick linings is indicated by its inclusion in the prevailing design code (DIN 28,060-3). It is not yet included in our ASME pressure vessel code.

Acid plant bypasses sulfur recovery

The Lurgi wet-contact sulfuric acid process recently made its U. S. debut—and added a new dimension to pollution control in the bargain.

Installed at U. S. Steel's Provo (Utah) works, the Lurgi unit makes 20 tons/day of

Now with 8 important improvements...
at no increase in price

New EPC CROUSE-HINDS EXPLOSION-PROOF MOTOR STARTER AND CIRCUIT BREAKER

The latest refinement in a long-tested, proved and improved explosion-proof combination Motor Starter & Circuit Breaker, this new Crouse-Hinds Condulet® EPC-M59 brings you tomorrow's convenience, dependability and safety at yesterday's prices.

Designed to conform with the National Electrical Code requirements for Class I, Groups C and D; Class II, Groups E, F and G; and Class III, it provides for built-in breathers and drains . . . built-in push-button stations, selector switch and pilot lights . . . seven taper-tapped conduit entrances . . . starter below breaker for safe, easy maintenance . . . compact design to permit a greater number of controls in any given area.

Now available in 7" and 9" sizes for Sizes 1 and 2 starter combinations. For more detailed information consult your Crouse-Hinds distributor, or any of the offices listed below.

ALL THESE NEW FEATURES

1 NEW raintight joints for both top and bottom covers

2 NEW shoes and guidance slot for easier interior assembly mounting

3 NEW built-in pilot lights available where visual indication desired

4 NEW easier-to-lock breaker handle (takes up to 3 padlocks)

5 NEW center section (and covers) of lightweight aluminum

6 NEW notched covers loosen quickly with pinchbar or screwdriver

7 NEW larger internal space for wiring ease

8 NEW replaceable 3-hole bracket makes mounting quick, easy

CROUSE HINDS

MAIN OFFICE AND FACTORY: SYRACUSE, NEW YORK
Crouse-Hinds Company of Canada, Ltd., Toronto, Ont
Crouse-Hinds Instrument Company, Inc., Silver Spring, Maryland

• CONDULET® ELECTRICAL EQUIPMENT (Explosion Proof and Conventional) • FLOODLIGHTING
• TRAFFIC CONTROL SYSTEMS • AIRPORT LIGHTING and WEATHER MEASURING EQUIPMENT

These products are sold exclusively through electrical distributors. For application engineering help, contact one of the following offices: Atlanta Baton Rouge Birmingham Boston Buffalo Charlotte Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Omaha Philadelphia Pittsburgh Portland, Ore. St. Louis St. Paul Salt Lake City San Francisco Seattle Tulsa Washington
Resident Representatives: Albany Baltimore Reading, Pa. Richmond, Va.

78% acid from a waste coke-oven-gas stream containing only 9-10% H_2S.* It thus serves a dual purpose, supplying sulfuric acid to the adjacent steel mill while safely abating a potential pollution hazard.

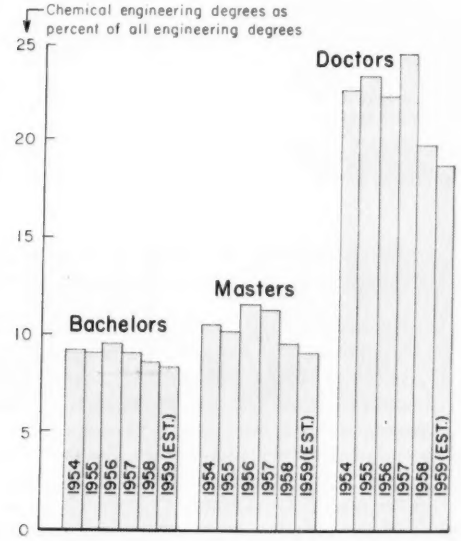
Developed in Germany and licensed in the U. S. through Blaw-Knox, the Lurgi process is designed specifically to operate on H_2S. It can handle feed streams containing anywhere from 2% to 30% H_2S and features a ceramic filter for acid mist removal.

Usual approach to H_2S disposal in recent years in this country has been via some form of the Claus process, in which the end product is elemental sulfur. The sulfur is sold in competition with mined sulfur and/or converted to concentrated acid in a conventional plant.

The Lurgi process combines these two functions in one unit, burning the H_2S directly to SO_2 and H_2O. Penalty, of course, is that the H_2O rides on through the converter and absorber, diluting the product acid. As far as USS is concerned, however, the Lurgi unit meshes perfectly with its other operations at Provo which consume dilute acid.

*SO_2 concentration, after combustion, is only one-third that normally encountered in contact acid plants.

Ups and downs of Ch. E. enrollments



Recently issued government statistics on engineering enrollments show that chemical engineers are still losing in percentage strength in the engineering profession.

Although in absolute numbers there will be more ChE graduates this year than any year since 1951, the percentage continues to slide (*see chart*). And the percentage will keep dropping for another year or two.

But the decline may flatten out by 1962. This year's class of engineering freshmen, while smaller than the entering class a year ago, is slightly stronger in percentage of those choosing chemical engineering.

Another trend to watch is the relative strength of ChE's among those receiving advanced degrees. Whereas the number of ChE's going into graduate study is just about holding its own, other engineering fields—principally EE—are putting increased emphasis on advanced degrees. Last year the number of EE doctorates (144) topped the number of ChE doctorates (127). This has happened only once before in recent history (in 1955), and then only by a margin of two (141 to 139).

Waste disposal schemes found wanting

"Paper Week" in New York last month served, among other functions, to bring the industry up to date on what chemical engineers were doing to solve the twin pollution and chemical recovery problems of neutral sulfite semichemical pulping.

Reviewing various recovery processes—both operating and proposed—Richard W. Brown of Hammermill Paper Co. told the National Council for Stream Improvement that no one system has proved completely satisfactory. "All the schemes have serious questions which must be answered, especially in the realm of process economics," explained Brown.

NSSC pulping has grown rapidly in the past 15 years as a means for utilizing vast stands of hardwood to make high-quality paper pulps. But pollution difficulties threaten to choke off further NSSC expansion. Hence a low-cost disposal process (which implies recovery of cooking chemicals as well) is an industry must. Among late developments:

• Green Bay Pulp & Paper Co., Green Bay, Wis., has submitted plans to state authorities for building the first big (60-ft.) atomized suspension reactor. Key step in this process (*Chem. Eng.*, Dec. 1955, pp. 118-120) is high-temperature pyrolysis performed in the absence of air. This volatilizes the organic part of the spent NSSC liquor to produce a sulfur-containing vapor stream and a sodium-containing inorganic solid residue.

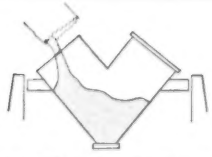
(Continued on page 90)

ENTIRELY NEW PRINCIPLE enables you to . . .

Blend liquids and solids intimately in one operation

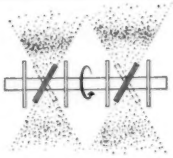
It is now practical, with the P-K "Twin-Shell"* blender, to blend many difficult formulations that have heretofore been either impossible or impractical because of the number of separate operations required to achieve a desired product. With the new "Twin-Shell" blender, liquids, solids, clumpy and crystalline materials can all be intimately blended in one operation. Average blending time: 5 to 15 minutes. The P-K "Twin-Shell" blender is unlike any other blender. It works on an entirely new blending principle. Here, in diagram, is how it works.

*Patented

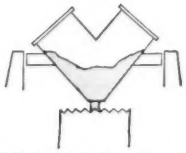


CHARGE DRY SOLIDS through top of either shell. Optimum charge level for most materials is about 65% of total shell volume.

TUMBLE AND AERATE. As shell revolves, rapidly spinning wire cage intensifier breaks up agglomerates, literally creates dust storm in material.

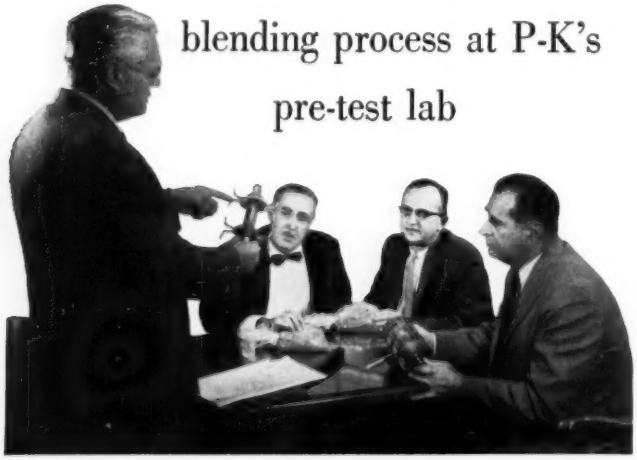


ADD LIQUID. Centrifugal force sprays atomized liquids from periphery of control discs on Liquid-Feed Bar into finely dispersed solids.



DISCHARGE PRODUCT easily through apex of shells. Accessibility of interior and easy removal of Liquid-Feed Bar speed cleaning.

Get new ideas for your blending process at P-K's pre-test lab



Complete, scientific investigation of all types of blenders now available at Patterson-Kelley.

Blending of complex formulations is full of variables. The equipment and procedure that are ideal for one combination of ingredients may be unsatisfactory for another. Proper selection of equipment demands thorough scientific investigation. You can conduct your investigation at Patterson-Kelley's Customer Pre-Test Lab, at East Stroudsburg, Pennsylvania. Since P-K makes practically all types of blenders, you can run conclusive comparison tests with your materials. Trained technicians will help you.

To set up an appointment, just place a collect call to Russell Dotter at Patterson-Kelley. Tel. No.: Stroudsburg 820. He'll be happy to tell you how much of your materials to bring and to give you other details. East Stroudsburg, in the Pocono Mountains, is just 2 hours from New York City, easily accessible by all carriers.

PROBLEM: to blend:—precisely—varying amounts of lumpy solids, powders, crystalline materials and small amounts of liquid.

SOLUTION: Charge materials to P-K "Twin-Shell" Liquid-Solids Blender. Press start button.

"TWIN-SHELL" Liquid-Solids laboratory models are made in transparent Lucite or stainless steel, in 8 and 16 quart sizes.

PRODUCTION MODELS of the "Twin-Shell" blender range up to 50 cu. ft. capacity. (Intensifier and Liquid-Feed Bar optional.)

VACUUM TUMBLE DRYERS by Patterson-Kelley are avaliable in sizes down to the standard 1 cu. ft. capacity lab model.

PRODUCTION MODELS of the Vacuum Tumble Drier have capacities up to 150 cu. ft., come factory aligned, piped, instrumented.

BLENDER LITERATURE. Specialized information and data in greater detail are given in two Patterson-Kelley publications: Bulletin No. 16, Chemical Process Equipment and Bulletin No. 15A-1, Twin-Shell Laboratory Blenders. Write for your copies today. Patterson-Kelley Company, Chemical and Process Equipment Division, 1503 Hanson St., East Stroudsburg, Pa. 15

Patterson Kelley

Chemical and Process Equipment Division

• The Zimmermann process (*Chem. Eng.*, Aug. 25, 1958, pp. 117-120) will soon go into operation on a large scale (500 tons/day) at a Norwegian paper mill, but no attempt is being made to regenerate cooking chemicals. The sodium sulfate residue from wet combustion of NSSC liquor can be converted to sodium sulfite, says Zimmermann, but this step has not been proved on a large scale.

• The Mead process (*Chem. Eng.*, Feb. 1957, pp. 168-170), in its first plant-scale (50 tons/day) trial at Watervliet Paper Co., Watervliet, Mich., ran into corrosion and heat-balance problems. A larger installation (200 tons/day) has just recently started up at Mead's own Lynchburg, Va., mill. In this process the liquor is concentrated and burned, as per kraft industry practice. Smelt from the furnace is converted to cooking liquor via two-stage carbonation and sulfiting with furnace flue gases; H_2S evolved during carbonation is recycled to the furnace.

• The Sivola process, now operating in Finland with some degree of success, is being considered in this country by Nekoosa-Edwards Paper Co. for recovery of acid sulfite liquor; no plans are known for using this process on semichemical liquors. The Sivola process resembles the Mead process. Principal difference is that Sivola uses essentially pure CO_2, rather than flue gas, for carbonation of the green liquor.

A detailed report of current experiments with the Bradley process at Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis., was given to TAPPI by Western Precipitation's Robert Boyer.

In this process (*Chem. Eng.*, Oct. 1957, pp. 166-168), sodium carbonate is separated from furnace smelt in a crystallizing evaporator; the mother liquor is recycled through the spent liquor concentration process, where it helps minimize corrosion in the kraft-type evaporators. According to Boyer, satisfactory present condition of the first effect's mild steel tubes confirms that the neutralized liquor is no more corrosive than kraft liquor. And good heat recovery on the furnace, says Boyer, makes it possible to burn NSSC liquor without additional fuel oil.

Udy smelting processes set to go

Commercialization of the Udy electric-furnace smelting technique appears imminent, despite the fact that recent newspaper reports concerning a proposed Canadian steel plant to use Udy's direct-reduction process turned out to be highly exaggerated.

Marvin Udy, originator of the process, tells *CE* that six other plants are on the drawing boards right now—for making chromium and manganese as well as steel. Strategic-Udy's 50-ton/day pilot plant at Niagara Falls, Ont. (*Chem. Eng.*, Apr. 1957, pp. 166-168), has been processing various ore samples to get pertinent design and performance data. When asked if he had any firm contracts, Udy replied that "although no contracts are signed, we are so close I hesitate to say no."

Raising quite a flurry last month were reports that a Canadian syndicate was going to erect a commercial Udy steelmaking plant. When the dust cleared, Koppers Co., potential builder of such plants, declared it had only a letter of intent to conduct a feasibility study for a group of Canadians.

Koppers' engineering and construction division, a major builder of blast furnaces and coke ovens, has been studying the Udy direct-reduction process for the past 18 months. In this process, iron ore is partially reduced in a rotary kiln; final reduction takes place in a submerged-arc furnace (*Chementator*, June 2, 1958, p. 48). Koppers says that 7-mill electricity is cheap enough for economic operation at many locations with modest capacities. Limiting size on a single electric furnace is put at 20,000 kw.—capable of turning out about 350 tons/day of pig iron or semisteel.

Tomorrow's Technology

Today's embryonic developments which have special significance for chemical engineers

New frontiers in graft polymers

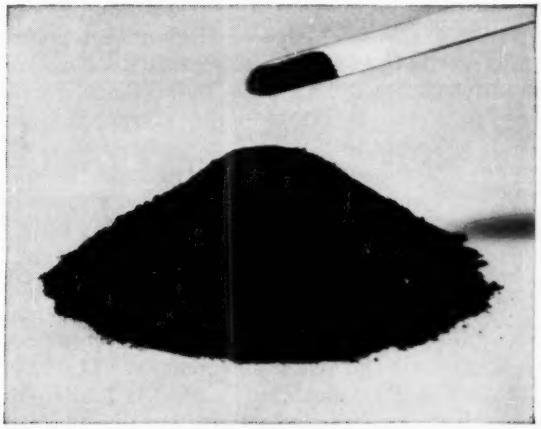
Radiation catalysis may be the magic lantern opening the door to wider production of graft polymers.

American Machine & Foundry will soon put on the market a new ion exchange membrane reported to be a sulfonated graft copolymer of styrene and polyethylene. The new material, possessing high permselectivity and low electrical resistivity, will sell at a price well below the approximately $2/sq. ft. level of present permselective membranes.

And Radiation Applications, Inc., New York, claims an economical radiation-grafting

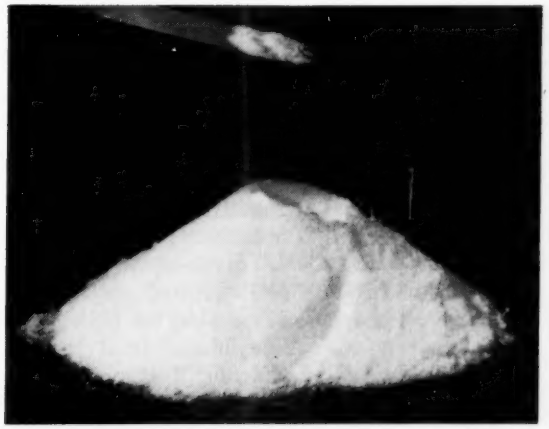
4 B&A® ACETATES... *and some of their uses*

Ammonium acetate, crystal, purified, $NH_4C_2H_3O_2$. These are small, slightly moist, colorless to white crystals. They are very soluble in cold water and alcohol. Uses of this exceptionally pure, high quality product include the manufacture of foam rubber and vinyl plastic, the dyeing of fabrics, and applications in explosives and pharmaceuticals.



Cupric acetate, crystal, reagent and technical grades, $Cu(C_2H_3O_2)_2 \cdot H_2O$. B&A cupric acetate is of highest quality and purity . . . also easy to handle. Reagent grade is used in the manufacture of synthetic fibers . . . technical grade in the manufacture of dyes, copper mirrors and printed circuits.

Calcium acetate, powder, purified, $Ca(C_2H_3O_2)_2 \cdot H_2O$. This is a high quality, white, free-flowing powder made from carefully selected raw materials. It should not be confused with ordinary gray acetate of lime, over which it offers many advantages. Its uses include the liming of rosins, catalyst in preparation of metal resinates, and varied applications in pharmaceuticals and foods. It is also used in the petroleum industry for the preparation of calcium soaps.



Potassium acetate, N.F. and technical, $KC_2H_3O_2$. B&A potassium acetate may be used as a humectant in various industries, such as textiles and cigarette paper manufacture. It has varied uses in the pharmaceutical industry.

For further information on any of these or other acetates—or any application ideas you may have—just drop us a line on your company letterhead asking for technical data or samples. If you'd like technical assistance, we'll be glad to work with you.

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GENERAL CHEMICAL DIVISION
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technique for imparting desirable surface characteristics to fluorocarbon polymers.

Up to now, graft polymerization has met with sporadic success. High-impact polystyrene is the only big commercial graft polymer today. According to a Dow patent, styrene monomer is grafted onto styrene-butadiene copolymer with the aid of mechanical scission.

In Britain, BX Plastics uses chemical catalysts to graft methyl methacrylate monomer onto natural rubber latex. In another technique, being researched in Britain, a fluorocarbon polymer is heated sufficiently to form free radicals on its surface, then dipped into a monomer, such as styrene, to produce a printable-surface graft polymer.

Surface modification, too, is RAI's objective. The firm grafts an undisclosed monomer onto a fabricated fluorocarbon polymer (tape, film, coated wire, etc.) under the influence of relatively low doses of radiation—beta, gamma or high-energy electrons. Products are much more easily bonded or dyed than straight fluorocarbon polymers.

No tanks for storage of liquid fuels

Although steel and concrete are here to stay, these traditional structural materials are conspicuous by their absence from some recent developments in bulk storage of petroleum fuels.

Southwest Research Institute, for example, suggests that a ditch or pit dug out of the ground with standard earth-moving equipment and lined with a prefabricated synthetic-rubber-coated fabric is suitable for bulk storage of motor fuels. A flexible cover of the same liner material or a flexible floating blanket of urethane foam can be used, if necessary, to prevent contamination or evaporation losses.

The San Antonio group estimates that such a 2-million-gal. reservoir—covering half an acre to an average depth of 15 ft.—would require only 500 man-hr. of field construction time, or only one-tenth the labor needed to put up a conventional steel tank.

In this study, sponsored by the Army Engineer Corps, SwRI has also experimented with ways to eliminate even the need for the coated fabric liner. General idea is to pave and seal the soil with a gel prepared by mixing petroleum fuel with an oil-wettable powder or clay.

Creole Petroleum Corp. in Venezuela has built a huge earthen storage pit for fuel oil along these lines. This $1-million reservoir, clay-lined and sprayed with asphalt, holds 3½ million bbl. of oil. Even with no cover on the pit, there is no contamination and negligible evaporation loss.

But for real cool storage, dig an ice pit. Army Engineers have found that aviation gasoline can be stored indefinitely in frigid zones in pits lined and sealed with ice slush and covered with plywood. There was no evaporation in more than seven months' storage, and the gas's moisture content was actually lowered.

Refiner aims for ultimate automation

Latest move by Sun Oil Co. to reach its avowed objective of automatic refinery operation is a joint study, in cooperation with Genesys Corp., Los Angeles, of a new automation system "free from preconceptions of the art of process control computing."

Sun has selected as guinea pig for this study a 60,000-bbl./day refinery unit at Marcus Hook, Pa. Operations performed in this unit include crude topping, catalytic cracking, vacuum distillation, visbreaking and gas processing.

Genesys Corp., a subsidiary of Chance Vought Aircraft, recently announced a line of process control equipment centering around what is called a "dynamic disk memory processor." However, Paul Barton, Sun's director of advanced management and methods, tells *CE* that no decision has been made, at this early stage in the study, as to whether or not Sun will use this particular equipment. "We're approaching this thing with a completely open mind," says Barton.

Chief economic objective of the study will be optimum methods for controlling quality of the various refinery streams. Closer quality control will lead to lower costs in subsequent operations which process these streams into other products.

Sun is leaving no stone unturned in its quest for more economical refinery operations. The Marcus Hook refinery is slated for first commercial process use of Westinghouse's new Opcon optimizing controller (*Chementator*, Jan. 26, 1959, p. 40). And Barton hints that Sun may give "conventional" computer control (such as Thompson-Ramo-Wooldridge's RW-300) a chance to prove its merits, too.

For more on DEVELOPMENTS.....94

Lubrication News

PROFITABLE IDEAS ON THE LUBRICATION OF CHEMICAL PROCESS EQUIPMENT

PLANT REDUCES LUBRICANTS FROM 27 TO 7—PROCESSING IS IMPROVED

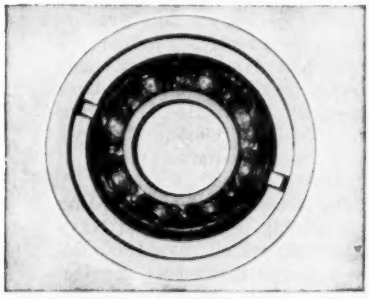
Multi-purpose greases cut lubrication costs

One plant in the basic chemicals industry has eliminated 20 lubricant specifications from its inventory. The maintenance supervisor reports that the plant is operating more efficiently than it ever did before.

This is just one example of a cost-cutting trend to fewer lubricants in chemical plants. Multi-purpose greases are replacing numerous specialty lubricants—even in areas of high heat, exposure to water or moisture, and oxidation or corrosion.

How multi-purpose greases cut costs

The most important cost-saving advantage of using multi-purpose greases is this: the man who lubricates equipment always uses the right grease. He doesn't have to choose the lubricant from among several drums. As a result, there's less chance of putting the wrong lubricant into a valuable piece of process equipment.



Bearing stopped in motion by high speed photography. Note how grease completely floods retainer and moving parts.

In addition, less lubricating equipment is required to apply multi-purpose greases. Perhaps only one grease gun will be needed for one entire part of a plant. And—there can be no confusion about which applicator goes with each lubricant. As a result, lubrication rounds take less time—labor costs go down.

Use of a multi-purpose grease also saves time in training lubrication crews, by making it easy to select the proper lubricant. It's easier, too, to set up a centralized, automatic lubricating system when only one lubricant is used.

Grease fully protects bearings

Multi-purpose greases are now available that completely lubricate all types of bearings and sliding surfaces. They also seal against dust, water contamination, or corrosive products and atmospheres.

These multi-purpose greases contain inherent properties that make them satisfactory for all except extreme or unusual operating conditions. They have good resistance to water washing. They will absorb limited amounts of water without change in consistency. They provide good resistance to oxidation. Maximum continuous usable temperature can be as high as 300° F. Stability on working is in many cases excellent.

New movie shows how grease tests predict performance in plant

How well will a grease stand up under pressure? How long will it resist washing by water? How much can it take before it shears or leaks? What happens under conditions of extreme cold? Heat?

A new movie, "Shear Magic," reveals how laboratory tests anticipate what happens when a grease is exposed to these conditions in the plant. Described are the "4-ball load test," which measures how well a grease stands up under pressure; water washing and rusting tests; leakage tests; and tests for resistance to heat, cold and wear.

The movie also shows how greases of all kinds are made, and explains the mechanics of grease lubrication.

A showing of the 25-minute sound and color movie can be arranged at your plant. Attach coupon at right to your letterhead.

Spray system protects open gears against abrasion by dust, dirt

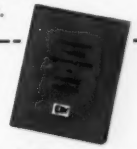
Open gears have long been lubricated by applying heated grease with a hand paddle. This has to be done when the gears are not running. Now, a spray application method makes it possible to lubricate open gears without machine downtime—and without sacrificing the complete protection required, especially in areas of excessive dust and dirt.

Another advantage of spray application is that it keeps the gears cleaner, less likely to foul up with contaminants.

The method described permits use of either manual or automatic spray applicators.

Management Practices Book

This guide to organized lubrication can help you achieve important savings in maintenance costs. It discusses methods that help raise production, extend parts life, cut downtime. For free copy, use coupon below.



THE TEXAS COMPANY
Dept. CE-CP-11
135 East 42nd Street
New York 17, N. Y.

I am attaching my company letterhead to this coupon.

- ☐ Send a copy of Management Practices that Control Costs via Organized Lubrication.
- ☐ Send more information on the movie, "Shear Magic."
- ☐ Ask a Texaco Lubrication Engineer to call at my plant.
- ☐ Can you help solve the attached lubrication problem?

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Title_____

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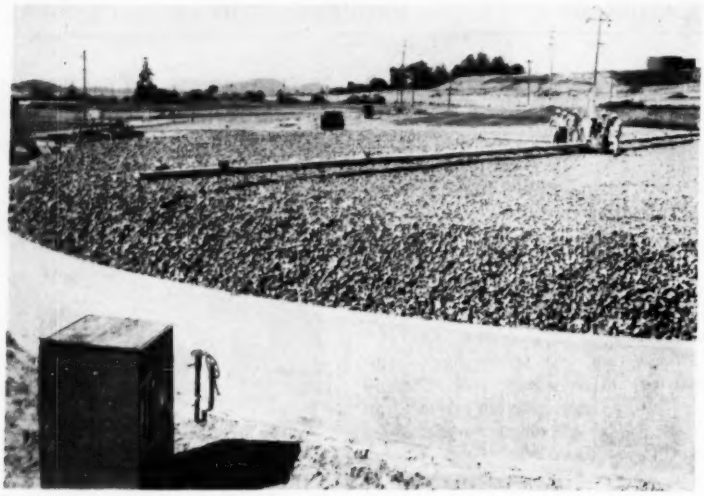
CBS Every Saturday Afternoon



FILTER holds new Washington refinery's phenol-consuming bacteria.

Refinery "Bugs" Put Bite on Phenols

Texaco's newest refinery depends on special bacteria for waste water clean-up.

Bacteria with an appetite for phenols occupy the starring role in Texaco's waste treating program at its new Anacortes refinery in Washington state's pollution-conscious Puget Sound area. A central waste-treating plant—built around the voracious bacteria—processes all refinery waste water before discharging it to the Sound.

Treating plant handles about 1 million gal./day of water from two sources: (1) clean water from storm sewers and boilers, (2) "oily" water from plant processes and tanker ballast tanks. Treating "clean" water consists merely of skimming debris and floating oil before sending water to the storage ponds.

At the heart of the "oily" water processing scheme are the bacteria developed to feed on refinery waste. Oily water entering the plant (average pH 8.5) contains about 20 ppm. phenols, traces of sulfides and mercaptans, and varying amounts of floatable and emulsified oil.

Floating oil and suspended solids are partially removed in an API separator. Treatment by lime, alum and silica gel in clarifiers forms precipitates to coagulate suspended solids and emulsified oil.

▶ **Stimulating Activity**—Prior to biological cleanup, steam and diammonium phosphate are injected into the water; steam raises water temperature to 85 F. to increase bacteria activity and the diammonium phosphate is a nutrient. Waste is pumped to the trickling filter, a circular rock pile 8 ft. high and 140 ft. dia., and is distributed by a perforated arm rotating slowly over the top of the pile. As water filters through the rock bed, resident bacteria consume phenols, sulfides and small quantities of oil.

From the trickling filter, water flows to aerator-classifiers where a slurry of activated sludge is mixed in for additional biological clean-up. Compressed air replenishes oxygen consumed by the biological reaction.

Water then flows to the first of two retention ponds for additional natural aeration, and then to the storage pond where it combines with treated "clean" water. Water discharged to the Sound has less than 0.2 ppm. phenols, 5.0 ppm. total oil, undetectable sulfide and mercaptans and a pH of 7.0.

View Clears Slightly on High-Energy Fuel Picture

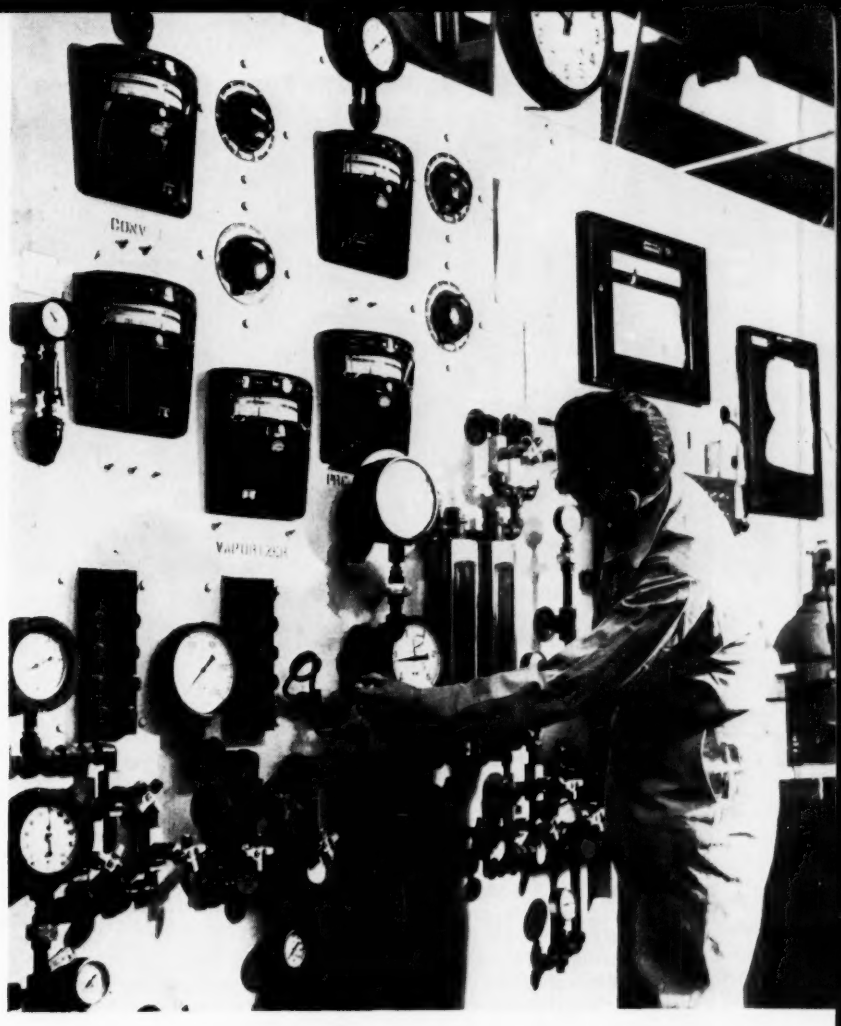
A rash of speculations followed recent announcement by Stauffer-Aerojet Chemical Co. that it has been awarded a $2-million Air Force prime contract for production of high-energy boron fuels. Contract covers construction and operation of a large pilot plant now being built near Sacramento, Calif.

Speculation stemmed from Stauffer-Aerojet statement that the new process being piloted is expected to reduce fuel production costs greatly. Further rumors had Navy cutting back sharply on production of Callery Chemical Co.'s Hi-Cal boron-based fuel and closing Callery's boron intermediates plant at Muskogee, Okla.

The latter is untrue, according to a quickly issued official Navy statement, which says 1960 Defense Department fuel requirements for Hi-Cal are undiminished. Statement, however, does not definitely rule out the possibility that Hi-Cal may go to the Air Force instead of the Navy.

Key to lower costs, say industry sources, is that Stauffer-Aerojet process involves recycle of certain reactants in fuel production. In processes used by Callery and by Olin Mathieson, no recycle is possible; byproducts must be discarded or collected, which gets expensive.

If Stauffer-Aerojet process does turn out boron hydrides at significantly cheaper cost, boron compounds might gain a new chance to jump into the chemical spotlight. New boron intermediates could find use as reducing agents and catalysts.



CENTER controls wide range of liquid- and gas-phase processes undergoing contract piloting.

Pilot Group Offers New Contracting Service

- **Undertakes complete pilot stage of client's development of liquid or gas processes.**
- **Saves client up to 50% on cost of piloting.**
- **Frees client's own personnel and equipment for assignment to other projects.**

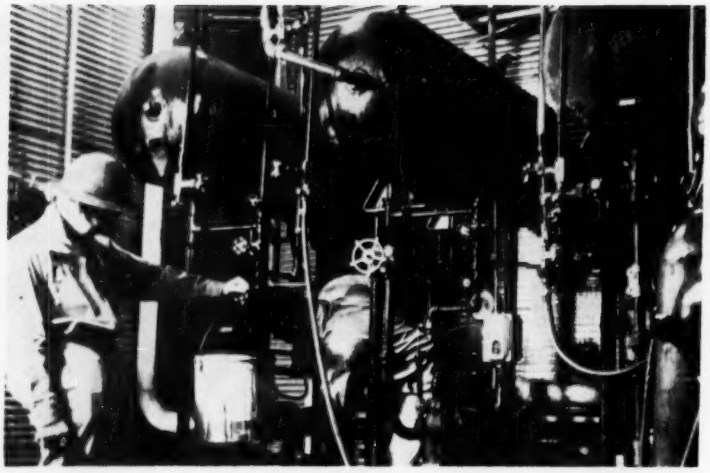
Add contract pilot planting to the growing list of services available for hire by the chemical process industries. In January, Armour Research Foundation opened a strikingly equipped, remarkably versatile $200,000 contract pilot plant on Chicago's south side.

Appealing to chemical engineers throughout the chemical process industries, ARF suggests that engineers let out their pilot work on contract to the Foundation and, thereby, sidestep traditional costs and headaches of scaleup from pilot to full scale.

Declares Bill Langdon, supervisory engineer at the pilot plant, "With this facility we can take on the full gamut of catalytic and noncatalytic processes involving liquid and gas streams. And we can deliver the full gamut of process and design information you need to make the transition from laboratory findings to profitable manufacturing plants."

Already, ARF has received a number of inquiries from a variety of chemical firms, has prepared program proposals for a few. Among the lively prospects Langdon cites hydrogenation of soybean oil, hydrogenation of toluene, catalytic reforming and cracking, polymerization of olefins, alkylation, life and activity studies on various catalysts.

▶**No Capital Charges**—Principal attraction of ARF's facility, Langdon points out, is complete elimination of capital investment usually required to conduct pilot and semiworks process studies. ARF's fee to the client includes only the actual cost of piloting represented by



OPERATOR adjusts valve on ground level of tower (exterior view on right) under scrubbers.

labor, materials and utilities (ARF is nonprofit organization). Able to charge this fee off as current expense, client is freed of capital charges for pilot equipment which may lie idle once project is finished.

Contract piloting by ARF will range from $15,000-$30,000/mo. depending upon the nature of the project, according to Langdon. "Quite informally, I'd guess that farming-out can slice a company's pilot-plant bill as much as 50%," he contends.

Admittedly, Langdon notes, the attraction of capital savings swings the greatest weight with medium-size companies—"those in the $15-$35 million gross sales class." Large enough to actively develop new processes, such companies still are not large enough to have their own extensive pilot-plant facilities.

▶ **Taps Talent Source** — But there are other virtues associated with contract pilot planting. For example, a company need not tie up scientific and engineering talent, plus equipment, on a particular project when these resources are already overloaded. Too, you can terminate a contract project abruptly without need to relocate personnel.

Where a company is venturing into unfamiliar areas, a contract with ARF taps diversified knowledge and experience within the Foundation. And as a further aid, ARF can arrange for client's personnel to participate on projects to learn process know-how for commercial-scale operations.

▶ **New Use for Tower**—Initially, ARF built this facility to pilot its own catalytic process for upgrading coal chemicals, demonstrated its flexibility in 1958 during year-long investigations of many process variations.

Equipment to provide this flexibility is located within the main processing area enclosed by 14-ft.-dia. by 48-ft.-tall tower. Four quadrants divide the tower internally; catwalks run around inside at three different levels above the ground.

Rising within quadrant containing tower's stairwell are power, sewer, steam, air, heating gas, water and instrument lines running to the processing stages.

Second quadrant holds, principally, three saddle-packed, 20-ft.-tall by 6-in.-dia. scrubbers. A sulfuric acid scrubber is fabricated of polyvinyl chloride; wash oil and sodium hydroxide scrubbers are black iron.

In the third quadrant are a packed steam stripper, an electrically heated vaporizer and a steam-heated vaporizer.

Standing in the fourth quadrant are two stainless-steel converters, 32-ft. tall by 2-in. dia., built to withstand up to 5,000 psig. These key process units can be packed with catalyst, left open internally, fitted with various baffle configurations, etc.

▶ **Auxiliaries on Level** — Attached to the processing tower-building is a 24-ft. by 36-ft. single-story auxiliaries and control center. Here are located a three-stage, 3,500-psi. reciprocating compressor; a well-fitted yet simple control panelboard; a compact analytical control lab, pumps and so on.

Pumps feed liquids up to 50 lb./hr. and 4,000 psi., compressors recycle gas up to 1,000 scfh. and 3,500 psig. Steam is available at 1,000 lb./hr. and 100 psi.; air at 25 scfm. and 100 psi.; water at 100 gpm.

Still further evidence of processing flexibility is shown by ability to vary reaction pressures up to 3,000 psi. And to provide reaction temperatures all the way from 200 to 2,000 F., ARF uses split-sleeve electric heating furnaces rated up to 250 kva. which fit around converters.

▶ **Easy to Set Up**—Key to easy setups for pilot runs is use of handle-bar, O-ring unions and fittings on all piping. With over 2,000 of these connections, pilot operators pull the piping apart and reconnect it in an infinite number of arrangements with great ease and without leaks, even when only hand tight.

Using the same type of connections on its panel board and instruments, ARF is free to change its manner of control and recording of process.

Every piece of equipment can be disconnected and moved at will. To exchange converters, after disconnecting from mountings, the pilot plant personnel simply hoist them out through opening in roof. New units are lowered into position the same way.

With this setup, ARF feels confident in offering to provide, correlate and evaluate all the significant process and design variables associated with successful pilot plant operations.

ARE YOU STILL SHIPPING THESE PRODUCTS IN DRUMS?

- ☑ Aluminum sulfate (alums)
- Ammonium chloride
- Ammonium nitrate
- Ammonium nitrate (fertilizer grade)
- Ammonium phosphate
- Ammonium sulfate
- Ammonium sulfate-nitrate
- Barium chloride
- Barium chromate
- Borax
- Boric Acid

- ☑ Calcium chloride
- Calcium cyanamid
- Calcium phosphate
- Casein (dry)
- Caustic Soda Flake
- Cellulose acetate
- Cement (specialties)
- Coconuts (shredded)
- Dishwashing compounds
- Disodium phosphate

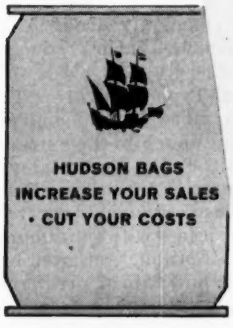
- ☑ Glues & pastes (vegetable dry)
- Insecticides
- Magnesium oxide
- Magnesium sulfate
- Meat scraps
- Milk, dried & powdered
- Monosodium glutamate

- ☑ Nylon monomer
- Potassium aluminum sulfate (alum)
- Polyvinyl Acetate
- Polyvinyl Chloride
- Potassium bichromate
- Potassium carbonate
- Potassium chloride
- Potassium magnesium sulfate (alum)
- Potassium nitrate
- Potassium sulfate
- Rice

- ☑ Salt
- Sodium bicarbonate
- Sodium bichromate
- Sodium bisulfate (nitre cake)
- Sodium orthosilicate
- Sodium phosphates
- Sugar
- Sodium resinate
- Sodium silicate
- Sodium sulfide
- Sodium thiosulfate
- Sodium hyposulfite
- Super phosphate (fertilizer)

- ☑ Tetro sodium pyrophosphate
- Trimethylolpropane
- Trisodium phosphate
- Urea

The MVT Sealer is also valuable to packers already using Multiwalls. The Hudson MVT Seal is far better and usually cheaper than wax-dipped ends.



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Hudson has a number of barrier sheets—foil wall, cold-proof AL, Moisbar, PE coated—which, singly or in combination, can positively safeguard a wide variety of sensitive products.

A new Hudson development, the MVT Sealer, now applies the same degree of protection for the ends as is available for the side walls. This solves the last remaining problem of Multiwall packing for such products as listed at left.

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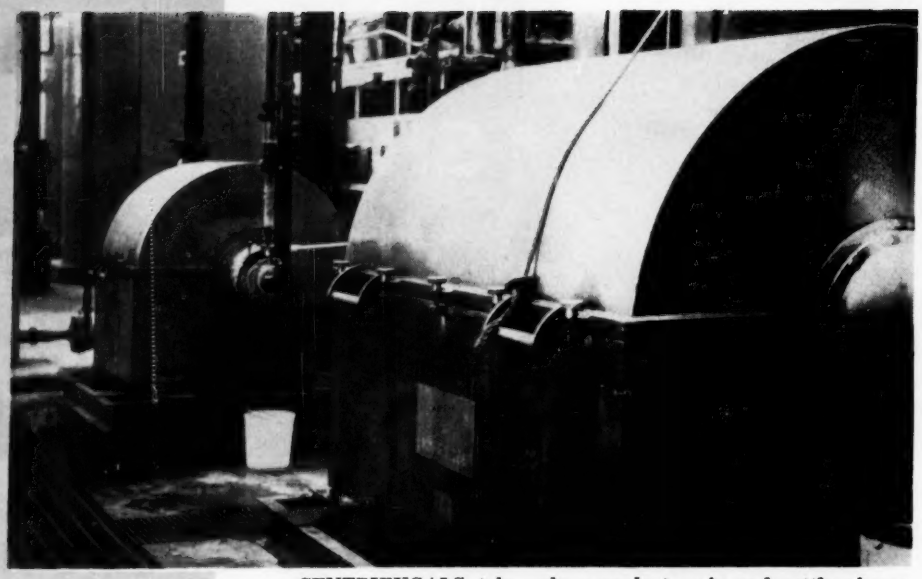
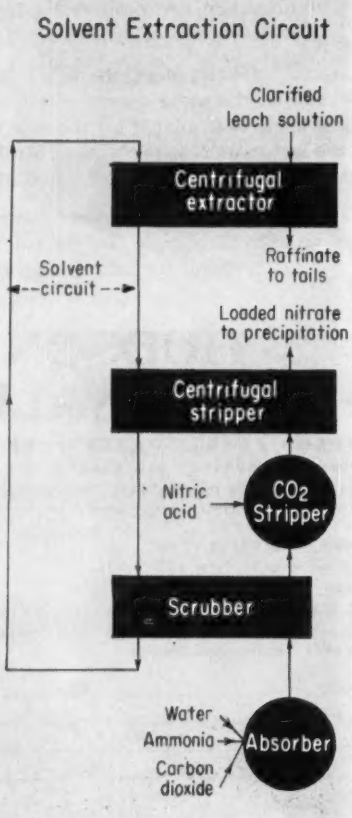


CENTRIFUGALS take only seconds to mix and settle phases.

New Extraction Circuit Cuts Solvent Use 95%



First centrifugal extractors in uranium industry speed up extraction, shrink installation size.

To find an authentic outpost of modern chemical engineering practice you need look no farther than the new 800-ton/day uranium mill of Texas-Zinc Minerals Corp. in remote village of Mexican Hat, Utah.

Until two years ago, this outpost Navajo Indian village in southeast Utah was easily one of the most isolated spots in the continental United States. Now, it claims distinction as the site of the first uranium mill to use high-speed centrifugal liquid-liquid extractors, rather than gravity mixer-settlers, in its solvent extraction circuit.

▶**Takes Only Seconds** — With this system, Texas-Zinc's operation seems more closely akin to chemical processing than to ore milling.

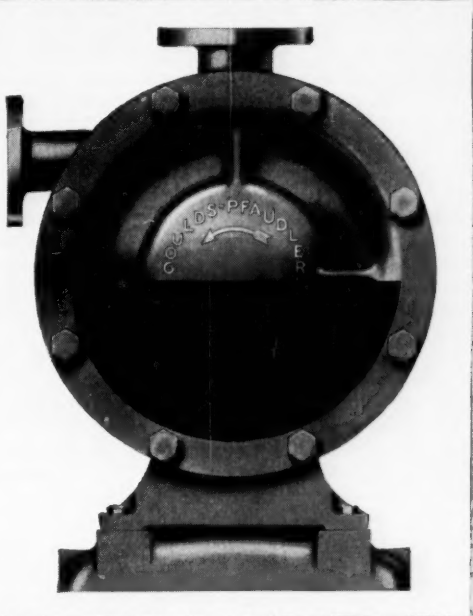
In a 15-sec. pass through the Podbielniak extractor, 500-gpm. of pregnant sulfuric-acid leach liquor gives up its 0.8 gpl. of U_3O_8 to 80-gpm. of organic solvent. A second pass through a Podbielniak stripper transfers the uranium values into ammonium nitrate solution for final recovery of U_3O_8 by precipitation with magnesium hydroxide.

▶**Speed Shrinks Size** — Rapid extraction speeds up the passage of solvent through the circuit, reduces 20-fold the amount of solvent inventory. Whereas, a conventional mixer-settler circuit would use 60,000 gal. of solvent (5-10% solution of Rohm & Haas amine LA-1), Mexican Hat requires only 3,000 gal. of solvent for same job.

Such major shrinkage in solvent inventory reduces piping and auxiliary equipment to a minimum, makes economical the use of Type 316 stainless steel in places where inferior materials are commonly used. And such shrinkage also reduces building size greatly.

▶**Chemical-Type Control** — To give even more of a chemical engineering touch to the extraction circuit, Texas-Zinc employs instrumentation techniques that assure close chemical control of the process with minimum operator attention. Actuated by changes in flow rate of pregnant liquor entering the extraction circuit, ratio controllers adjust

ACETIC ANHYDRIDE ALUMINUM SULP
HATE BORIC ACID CARBON TETRACH
LORIDE CUPRIC CHLORIDE ETHYL AC
ETATE FERRIC NITR
FERROUS SULPHAT
GLUTAMIC ACID IO
THANOL MONOCHL
NOETHANOLAMINE
LPHORIC ACID PHO
LORIDE PHENOL P
TASSIUM PERMANG
D PYROGALLIC ACI
IUM SULPHATE SOI
PHITE OXALIC ACID
TIC ACID METHANO
TRIETHANOLAMINE
WATER - DISTILLED
MONIUM HYDROXID
OXIDE SODIUM HYI
SODIUM CAR
CHLORITE



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PUMP CORROSIVES WITHOUT CORROSION

Every surface that comes in contact with the pumpage is protected by glass fused to metal—in the Goulds-Pfaudler Fig. 3708 glassed centrifugal pump.

This pump can lick your corrosion or contamination problem when pumping corrosives like those listed here (and hundreds more). The tough glass-to-metal bond resists most acids at temperatures up to 350°F and alkalies at moderate temperatures. And, because glass is so smooth, it discourages product adhesion and scale build-up. No loss of product due to contamination, since glass is inert.

Choose from four different sizes and get capacities up to 700 GPM, heads up to 140 ft.

Write for Bulletin 725.2 for details, plus a second booklet, "It's What's Inside That Counts," for the inside story. Address Goulds Pumps, Inc., Dept. CE-39, Seneca Falls, New York.

GOULDS PUMPS

other flow rates accordingly. Only five men are needed to run the entire mill.

▶ **Incoming Ore**—Mexican Hat's operation starts with ore that contains copper and iron, as well as uranium. After crushing to $-\frac{3}{8}$-in. size, sampling and blending, ore passes over continuous weighing belt. Then after pulping, it is ground to −35 mesh by rod mill and ball mill running in closed circuit with a 72-in. spiral classifier.

The CuS mineral released by this grinding is conditioned for subsequent separation by injection of amyl xanthate at ball mill inlet.

▶ **Separate and Leach** — From grinding circuit, −35-mesh ore goes through flotation circuit for separation of CuS flotation concentrate and tails containing bulk of uranium values. Then, in separate circuits, these two ore fractions are leached with sulfuric acid to remove uranium.

By leaching these two fractions separately, Texas-Zinc reduces appreciably the amount of MnO_2 reagent needed to oxidize the uranium. Leached copper concentrates are filtered with a drum filter to yield copper concentrate for sale and a uranium-bearing liquor which joins leach pulp leaving the tailings leach circuit.

Leach pulp is washed free of pregnant liquor in a five-stage countercurrent thickener circuit, using Separan 2610 flocculent in each thickener to accelerate solids settling rate. Pregnant liquor overflowing the first stage passes through precoat filters for final clarification before extraction.

▶ **Centrifugal Extraction**—Pregnant liquor flows under pressure into the spinning extractor rotor through hydraulically balanced mechanical seals. Constituting the heavy phase, this liquor starts its extraction pass from a position near the axis of rotation. Centrifugal force, generated by 1,250-rpm. speed, moves the pregnant liquor outward where it contacts and displaces the relatively lighter solvent fed to the centrifugal's periphery.

The separate phases mix intimately as they pass through orifices in the contacting elements. Phase separation takes place between elements, resulting in efficient multistage extraction. Calming sections at the outer diameter and center of rotor provide clear effluents.

Texas-Zinc's particular choice of amine solvent was influenced by solvent's high selectivity for uranium in the presence of iron. It is not necessary to reduce ferric iron to the ferrous state to prevent pickup and carryover with the uranium. Any ferric iron picked up by the solvent is eventually displaced by uranium as solvent becomes saturated.

Being a secondary amine, the LA-1 can tolerate molybdenum since any molybdenum picked up remains soluble in the kerosene diluent. Continuous stripping of a small bleed stream with sodium carbonate keeps molybdenum content in balance.

▶ **Strip and Recover** — Loaded solvent from the extractor enters a second Podbielniak for stripping with ammonium nitrate solution which reaches a concentration level of 50-60 gpl. U_3O_8.

Solvent effluent, containing about 0.06 gpl. U_3O_8, recycles to extraction centrifuge. Raffinate from extraction contains

Acrylic Fiber Joins Linen in Irish Economy

Long noted for the quality of their linen products the Irish soon will have acrylic fiber to work into their textile industry. This new $9-million plant at Coleraine, County Londonderry, Ulster, North Ireland is expected to produce 10 million lb. of Acrilan acrylic fiber in 1959. Property belongs to Chemstrand, Ltd., British subsidiary of Chemstrand Corp., Decatur, Ala., one of nine American companies now operating in Ireland and strengthening its economy.

New cars stay bright and shiny 3 times longer with acrylic lacquers made with

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Many of the new car models are finished with acrylic lacquers which give three times the durability of conventional finishes. Enjay Methyl Ethyl Ketone is one of the most important solvents used in the formulation of these new lacquers that provide smoother, tougher, more durable finishes. Acrylic lacquers give more beautiful, longer lasting finishes to furniture, too. For the highest quality in lacquer solvents, specify Enjay Methyl Ethyl Ketone.

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EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

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only 1 ppm. U_3O_8 under optimum conditions.

Magnesium hydroxide neutralization of loaded nitrate solution precipitates U_3O_8 yellow cake which is thickened, washed, filtered, dried and packaged for shipment.

Petrochemical Complex Slated for Down Under

Standard Vacuum Oil Co. is providing the cornerstone for a new $50-million petrochemical center in Australia, a joint venture of American and Australian companies.

Project will involve four new plants, all located near Melbourne. End products will include polyethylene, polystyrene and GRS synthetic rubber. Key unit will be an ethylene-butadiene plant built by Stanvac's Australian affiliate, Vacuum Oil Pty., Ltd. Raw material will be piped from Stanvac's nearby Altona petroleum refinery.

Union Carbide's Australian affiliate will erect a 15-million-lb./yr. polyethylene plant adjacent to the Stanvac unit. Another chemical company, still to be formed, will build the styrene plant.

Styrene and butadiene will be the raw material fed to the fourth plant that will make GRS rubber. Australian tire manufacturers will be invited to invest in this fourth plant; synthetic rubber output will aid the Australian government in its battle to cut its foreign exchange requirements.

Tiny Atomic Cell Generates Electricity

Latest payoff in the research going on in thermoelectric materials (*Chem. Eng.*, Dec. 15, 1958, p. 82) has been registered by Minnesota Mining & Mfg. Co. Working as a subcontractor to the Martin Co. of Baltimore, Md., 3-M has developed a lead telluride alloy thermocouple that can convert the decay energy of radioisotopes into electricity with efficiencies up to 8-10%.

The new thermocouples are the heart of the Atomic Energy Commission's SNAP III (Systems for Nuclear Auxiliary Power) nuclear electric power device which the AEC recently unveiled. Weighing only 5-lb., the operational model of SNAP III converts the radiation emitted by 0.33 g. of polonium-210 into three watts of electricity. SNAP III is only 4.75 in. dia. and 5.5 in. high.

AEC estimates that in 280 days (two half-lives of the polonium) SNAP III can produce electricity equivalent to 1,450 of the best conventional batteries. And efficiency of the device increases with decreases in temperature — unlike conventional batteries which are adversely affected by cold weather.

▶**What's Next?**—It's reported that a similar device will power the television cameras in this country's planned reconnaissance satellite. Other potential uses include navigation aids and communication lines where batteries are now used and require frequent attention.

Several improvements will be made in the "proof-of-principle" SNAP III: $600 worth of cerium-144 will probably be substituted for the $30,000 polonium-210 source. Weight of the unit can probably be cut to 3 lb. while boosting output to five watts. And cost can be cut to a few hundred dollars from the prototype's $15,000 cost.

Pilot Plant Will Make Fresh Water From Brine

Now under construction at Syracuse, N. Y., Carrier Corp's new 15,000-gal./day saline water-conversion pilot unit will use Carrier's previously piloted (on a 300-gal./day scale) direct —freeze process. Carrier expects to complete the pilot-plant test program in 12-18 months, then hopes to qualify for one of the million-gal./day plants authorized by Congress.

In direct-freeze process, water is sprayed into a chamber under partial vacuum at a temperature of about 25 F. Part of the water (about 15%) evaporates, causing the rest of it to form relatively pure ice crystals and brine. Crystals are washed countercurrently with water in a column, and then are melted as water vapor from freezing chamber condenses on it.

Attractive advantages of direct-freeze method are low corrosion due to low temperatures, and low energy needs since heat of fusion is about one-seventh that of vaporization.

NEWS BRIEFS

Gas-processing plant: Texas Natural Gasoline Corp. and Tennessee Gas Transmission Co. now have on stream a 150,000-Mcfd. natural-gas-liquids recovery plant about 15 mi. southeast of New Orleans, La. Plant, built by Fluor Corp. and operated by Texas Natural Gasoline, will recover initially about 380,000 gpd. of liquid product by absorption-refrigeration at −20 F.

Caffeine: Stanford Research Institute is readying pilot plant trials of solvent-extraction methods to produce caffeine from coffee beans in Brazil. If successful, process could win as much as 2 million lb./yr. of caffeine from some 260 million lb. of "expurgo"-grade bean, which represents bottom 10% of Brazil's annual coffee crop. Basic process involves extracting oil from coffee with benzene, followed by hot water extraction of caffeine from oil.

Isobutane: Standard of California is building a 2,000-bbl./day Butamer unit at its Richmond, Calif., refinery. Process, licensed by Universal Oil Products, uses fixed-bed catalyst in hydrogen atmosphere. (See *Chem. Eng.*, Apr. 21, 1958, p. 66.)

Rhenium: Chase Brass & Copper Co. is now in commercial production of wrought rhenium rod, wire and strip via powder-metallurgy techniques. In 100-lb./yr.-capacity facilities at Waterbury, Conn., Chase produces the metal by hydrogen reduction of the ammonium salt (NH_4ReO_4) to rhenium (m. p., 5,756 F.), followed by a vacuum sinter at 2,200 F. and a hydrogen sinter at 5,000 F.

ENGINEERS "DISCOVER" ALCOA CONDUIT

Lower cost, installation economies, corrosion resistance make Alcoa Aluminum the best conduit buy

An increasing number of cost-conscious engineers are switching to aluminum rigid conduit for office buildings, industrial plants and other new and remodeled structures. Here are some of the reasons why:

- Lower prices plus light weight and ease in handling make Alcoa® Aluminum Conduit installations competitive.
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- Aluminum is easier to cut, bend and thread. Wire pulling is easy, too, because of specially treated internal surface.
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- Clean, modern appearance complements modern architecture.
- Aluminum is nonsparking and has Underwriters' Laboratories, Inc., approval.

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Underwriters' Laboratories, Inc. INSPECTED RIGID CONDUIT ISSUE MU-28

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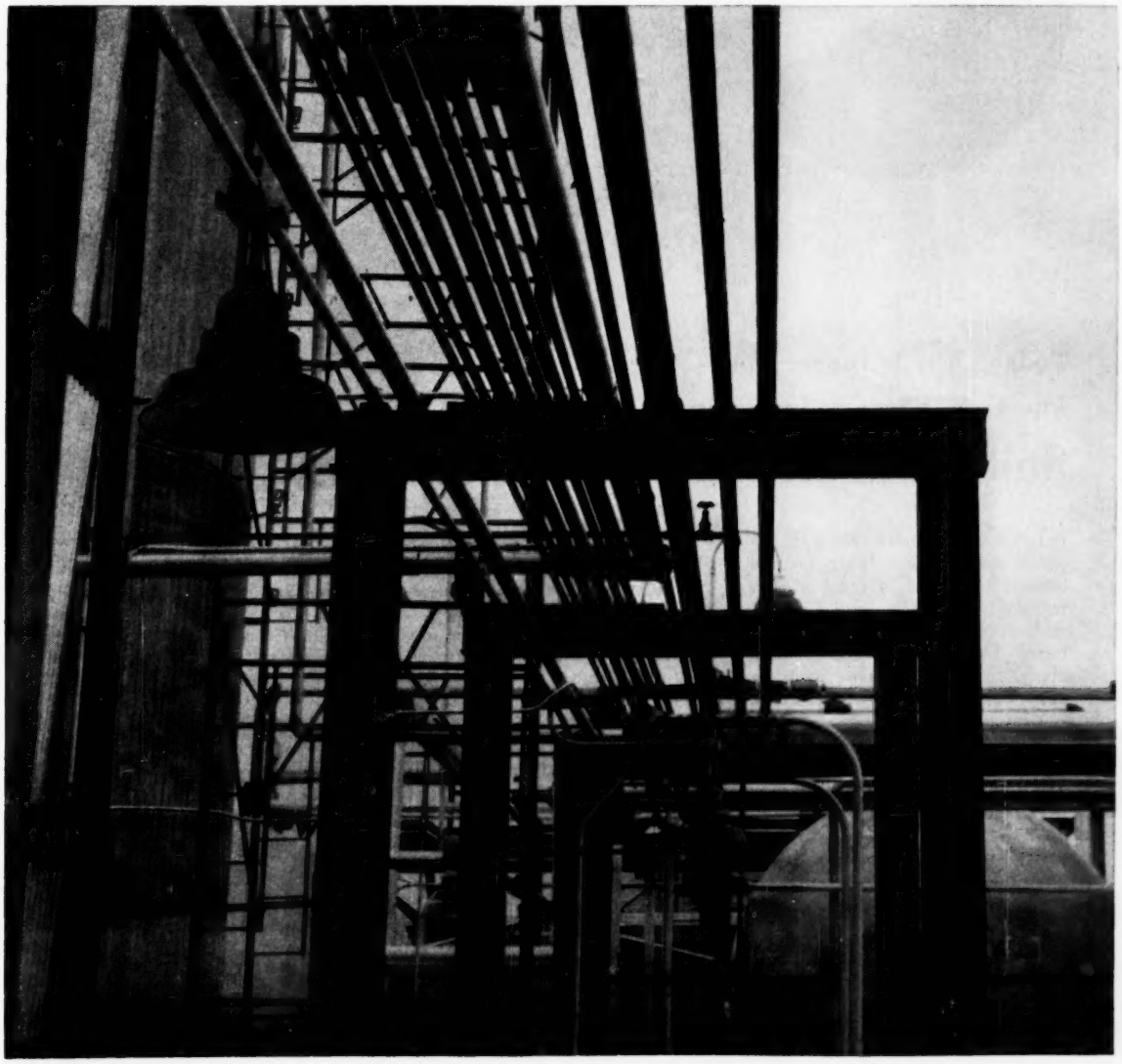

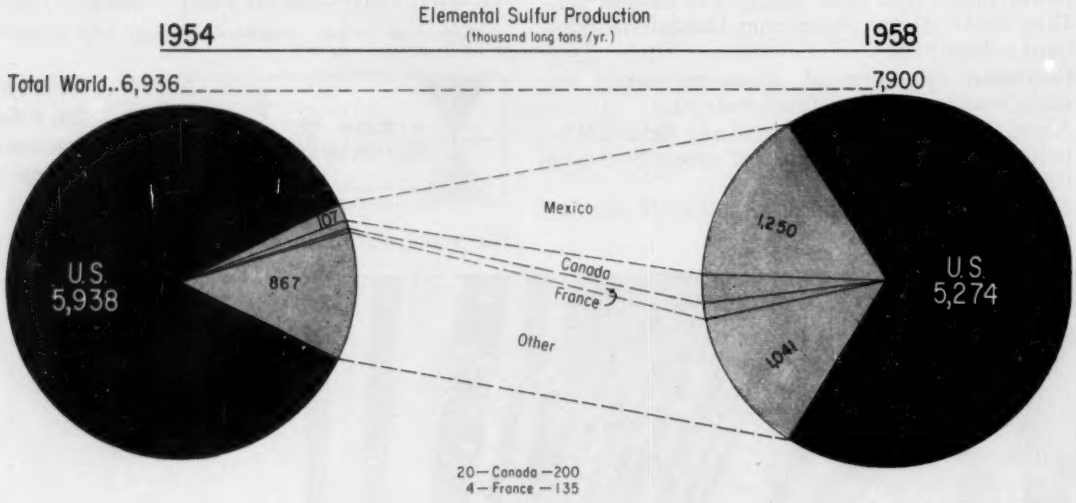

Today's Pie Is Bigger, but The U. S. Share Is Less, as:

Sulfur's World Supply Pattern Changes

In a little more than three years the sulfur industry—once one of the world's most stable industries, with well-defined, well-ordered supply lines—has been transformed into a very competitive business with a very competitive future.

New production is shaping up where little existed before. Mexico has brought four Frasch sulfur deposits into production—the only important ones outside the U. S. Canada is bursting with a sulfur-from-natural-gas potential begging to be released. France is dipping into rich supplies of sour gas.

And the swelling flow of crude oil to Europe and tightening pollution control measures in the U. S. mean more sulfur recovery by refineries.

The very latest news of looming new sulfur production comes from the Stettler-Davis gas-producing area near Calgary, Alta. There a $3-million natural-gas-and-sulfur-processing plant will be built—by six petroleum producers in the area—astride Trans-Canada Pipeline's conduit serving eastern Canada.

▶ **Demand's Up Too**—Of course sulfur demand is strengthening, too—strengthening in tune with the recovery in general business conditions. For sulfur's fortunes have long been tied—largely through sulfur's chief end use, sulfuric acid—to world economy.

Sulfur producers expect, in fact, a healthy 3.5-4% increase in annual consumption for some years to come. This will mean a world need for 500,000-600,000 long tons more sulfur this year than last, due to normal growth alone. Credit 1959, too, with a one-million-ton increase in sulfur consumption as the nation's economy returns to its pre-recession level.*

As for the 1960's, just as there are new producers springing up so are there new markets appearing in unlikely places. Cuba, which consumes perhaps

* One usual consequence of market contraction is a buildup of inventories. Frasch sulfur has been no exception—stocks at the mines rising from 3.6 million long tons in 1956 to 4.5 million long tons in 1958. Of this, Texas Gulf Sulphur has two-thirds, or 3 million tons, having chosen to maintain high-level production despite reduced shipments. TGS's high inventory gives it an above-the-ground potential greater than its total 1958 shipments, a potential which was gathered for the most part at lower-than-current production costs.

A TECHNICAL MEMO FROM THE QUAKER OATS COMPANY ON

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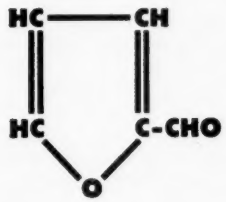

GENERAL PHYSICAL PROPERTIES

Boiling point (at 760 mm), °C.	161.7
Freezing point, °C.	−36.5
Refractive index (n 20/D)	1.524-7
Specific gravity, 20/20	1.161-3
Solubility in	
water (wt. % at 20°C.)	8.3
alcohol; ether	∞

FLUID PROPERTIES

Viscosity, cps. at 25°C.	1.49
at 38°C.	1.35
Surface tension, dynes/cm. at 30.0°C.	41.1
Vapor diffusion coefficient, cm^2/sec.	
at 25°C.	0.087

THERMODYNAMIC PROPERTIES

Heat of vaporization, $\triangle H_{433.8}$ kcal./mole	10.22
Thermal conductivity, B.T.U./(hr.) (sq. ft.) (°F./ft.) at 100°F.	0.1525

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U.S. Sulfur Exports Back Down As Foreign Competition Grows

	Thousand Long Tons 1954	1959*
France	000	300-500
Mexico	15	1,100-1,300
United States	1,645	1,400-1,500
Canada		100-200

* *Chem. Eng.* estimates

20,000 tons/yr. today, may need 150,000 tons next year, 300,000 tons by 1962. Brazil may step up its sulfur use from 125,000 tons/yr. to 250,000 tons in a couple of years.

Japan, although it has well-established pyrites and elemental sulfur production today, may find its rapidly growing sulfur needs too much for internal production. Even Taiwan and Korea could turn into attractive markets.

▶ **Old Order Changeth**—Fred M. Nelson, Texas Gulf Sulphur's board chairman, sums up the situation candidly in this manner: "The current sulfur market, tied as it is to general business conditions, is strong and growing stronger. But sulfur supply, augmented by new production in Canada, France and Mexico, is competing actively for the market. . . . U. S. Frasch producers will be working overtime to maintain their positions in world markets."

Statements like this show that the U. S. sulfur industry is not trying to kid itself and others into believing that the world sulfur picture has not changed sharply and probably permanently. The old status quo is no more.

Domestic Frasch producers are not sitting idly by while the rest of the world rocks the sulfur boat. To present a united front once again in export markets, the producers have reorganized the Sulphur Export Co. which had been disbanded five or six years ago. This group effort, which assures each domestic producer his historical share of export markets, helps to stiffen and stabilize export price structures, and, in general, to meet foreign competition.

▶ **Hedging**—U. S. Frasch producers are also getting into the very same areas which threaten their world-wide markets. Texas Gulf produces Frasch sulfur in Mexico; Texas Gulf and Jefferson Lake are busy in the Canadian sour gas fields (see table, p. 108).

Mexico is now a major producer of Frasch sulfur, turning out 1.2 million long tons last year and perhaps more this year.

French production of sulfur from sour gas will rise from December 1958's level of 300,000 long tons to 700,000 long tons by the end of 1959. French shipments might reach 400,000-500,000 long tons this year, compared to 130,000 long tons in 1958.

Canada may chime in with another 350,000 long tons of sour-gas sulfur (up from 180,000 long tons in 1958) to add to its already sizable sulfur-in-pyrites potential. Much depends on government permission to move natural gas to U. S. customers. (*Chem. Eng.*, Dec. 15, 1958, pp. 86-88.)*

And Italy still supplies most of her own sulfur needs through government-subsidized mining.

There's a tremendous sulfur potential in Canadian natural gas to be sure. Some estimates of presently economical reserves run as high as 260 million long tons. But how this sulfur lode will eventually be developed, and how fast, is more difficult to assay.

Speaking of potentials, France is figured to have 70 million long tons of sulfur locked in the Lacq natural gas deposits. French sulfur potential is more apt to be exploited in the near future than is Canadian potential because of larger, nearer and more immediate markets for petrochemicals, fuel and sulfur.

▶ **Target Is Pyrites**—Much of the French output is aimed at displacing pyrites sulfur. And with good reason, for pyrites sulfur is a mammoth business in Europe. More than 3 million tons of sulfur in pyrites form is consumed each year, enough to satisfy half the total European need for the yellow mineral. (Smelter gases, gypsum, and spent oxide supply 1.5 million tons of sulfur; Frasch deposits and sour gas supply 1.5 million tons.)

Sulfur from pyrites is under strong economic pressures from elemental sulfur throughout Europe. Britain is getting more and more of the sulfur she needs from her booming petroleum refining business. In fact, as more and more foreign crude moves into Europe, local refining can chip in more and more elemental sulfur.

Since 1956, according to one report, virtually all new sulfuric acid plants in the UK, France, Holland and Belgium have been designed to burn elemental sulfur. (Capital cost of a pyrites roasting plant is about double an elemental sulfur-burning setup.)

One small satisfaction from an otherwise distasteful move—the price cuts for Frasch sulfur—came from further inroads by Frasch sulfur in pyrites markets in Europe.

▶ **No Sitting Duck**—Pyrites utilization is well entrenched in Europe, particularly in Germany where the iron in the iron-sulfur combination is used to feed the steel industry after metal values, like copper, are recovered. With high prices prevailing for iron ore, the iron

* Let's remember, though, that Canada has extensive deposits of sweet natural gas which are quite likely to be tapped preferentially.

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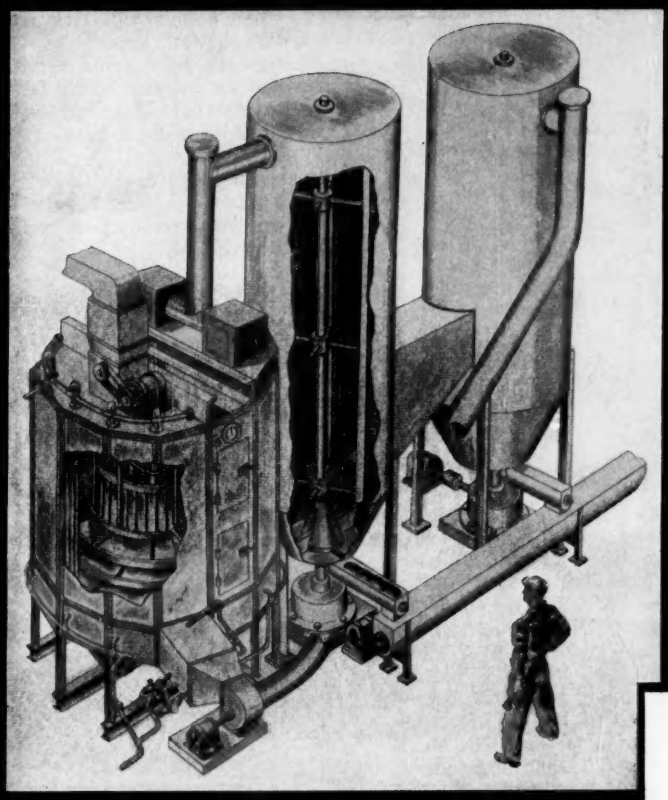

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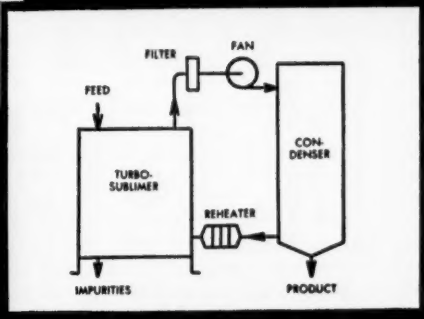

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New Sulfur Ventures in New Places: Producers Hedge Against Foreign Challenge

Texas Gulf Sulphur

In Mexico:
An $8-million Frasch plant already producing from the Nopalpa Dome—over 200,000 long tons stockpiled to date. (Texas Gulf's Mexican subsidiary, Exploradora del Istmo, is handling this operation.)

In Canada:
An $8-million sulfur-extraction unit onstream this year at Okotoks, near Calgary, Alta.—rated capacity will be 370 tons/day. (A joint venture with Devon-Palmer Oils, Ltd.)

Freeport Sulphur

In the U.S.:
A $30-million Frasch plant ready by 1960 to tap reserves off Louisianna shores (at Humble Oil's Grand Isle property leased from U.S. government).

In Mexico:
Acquisition of sulfur properties of Houston's Sulphur Exploration Co. on the Isthmus of Tehuantepec.

Jefferson Lake Sulphur

In Canada:
Set up Jefferson Lake Petrochemicals of Canada, Ltd. to handle sulfur operations. The Peace River, B.C. sulfur-from-gas extraction plant stockpiled 50,000 tons last year, is operating at a 300-ton/day rate this year. The East Calgary Field extraction plant (joint project with Mobil Gas of Canada) might start up in 1960 if all goes well with West Coast Transmission's plans to pipe natural gas from Mobil Gas's wells to the U.S. The Savanna Creek, Alta. project—a proposed 500-ton/day sulfur-extraction plant—awaits government approval of natural gas export.

values in pyrites have had as a result a ready market in recent years.

Pyrites sulfur is no sitting duck elsewhere, either. A huge newly constructed fertilizer plant in South Africa relies on local pyrites sources for its sulfuric acid needs. Uranium mines in the Blind River area of Canada get sulfuric from pyrites roasting.

Thus, even uranium production—a big user of sulfuric acid—is not fair game everywhere for elemental-sulfur burning. In South Africa, uranium recovery stems largely from gold tailings—which, incidentally, also provide the acid needed to extract the uranium. The Blind River uranium complex in Quebec also draws its acid from Canadian Industries' plant at Sudbury, which in turn gets its sulfur from International Nickel's smelter gases.

▶ **Export-Import Troubles**—Little wonder, then, that U. S. Frasch producers find life much more difficult these days. Imports of sulfur are on the increase—212,000 long tons in 1956, 496,000 in 1957, over 600,000 last year (mostly from Mexico).

U. S. export stakes—amounting to 1.5 million tons/yr. in 1958—are under fire. The Mexicans moved 75,000 long tons of Frasch sulfur into Australia last year, 50,000 long tons into South Africa, 50,000 tons into the United Kingdom. Even Red China got into the act, reportedly squeezing 10,000 long tons of sulfur into the Australia-New Zealand market.

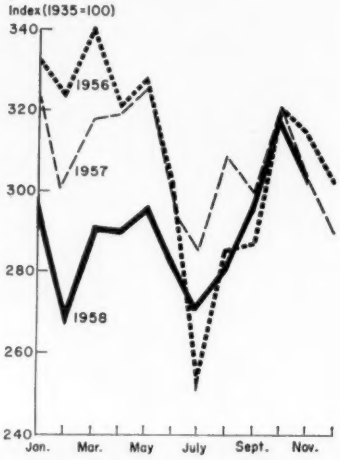
Mexican producers have been particularly aggressive. Not only are they willing to offer cheaper sulfur at the port of shipment but they can ship the stuff to the U. S. ports at lower cost because they are permitted to use foreign vessels whereas the U. S. Frasch producers must go along with higher-cost American shipping.

We've drawn what may appear to be a gloomy picture, perhaps, for the U. S. sulfur industry. Actually it is not gloomy, only changing. We've tried to emphasize the factors behind the change, rather than to dwell on the factors which have made U. S. sulfur producers strong and will help them adjust to the changes.

If, as some people predict, the 1957 sulfur price is restored and sticks, then things will look a whole lot better immediately. (Although it's hard from here to see how an increase would be justified this year. Most factors apparent today seem to rule out the possibility.)

Meanwhile, let's figure on our sulfur producers having been in the business far too long to lose the initiative now.

Chemical Consumption



Consumption by Industries

	Oct. (Final)	Nov. (Est)
Coal products	8.7	9.2
Explosives	11.4	10.1
Fertilizer	69.6	69.7
Glass	29.2	25.7
Iron & Steel	16.2	15.7
Leather	24.3	24.5
Paint & Varnish	33.8	29.3
Petroleum refining	30.9	30.3
Plastics	30.6	29.8
Pulp & paper	41.6	38.2
Rayon	26.0	24.4
Rubber	7.5	6.8
Textiles	10.4	10.5
Total	**320**	**304**

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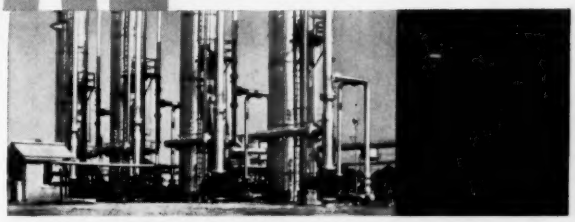

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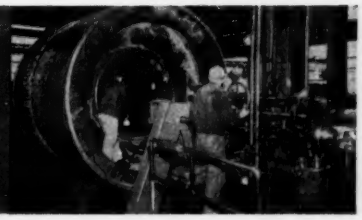

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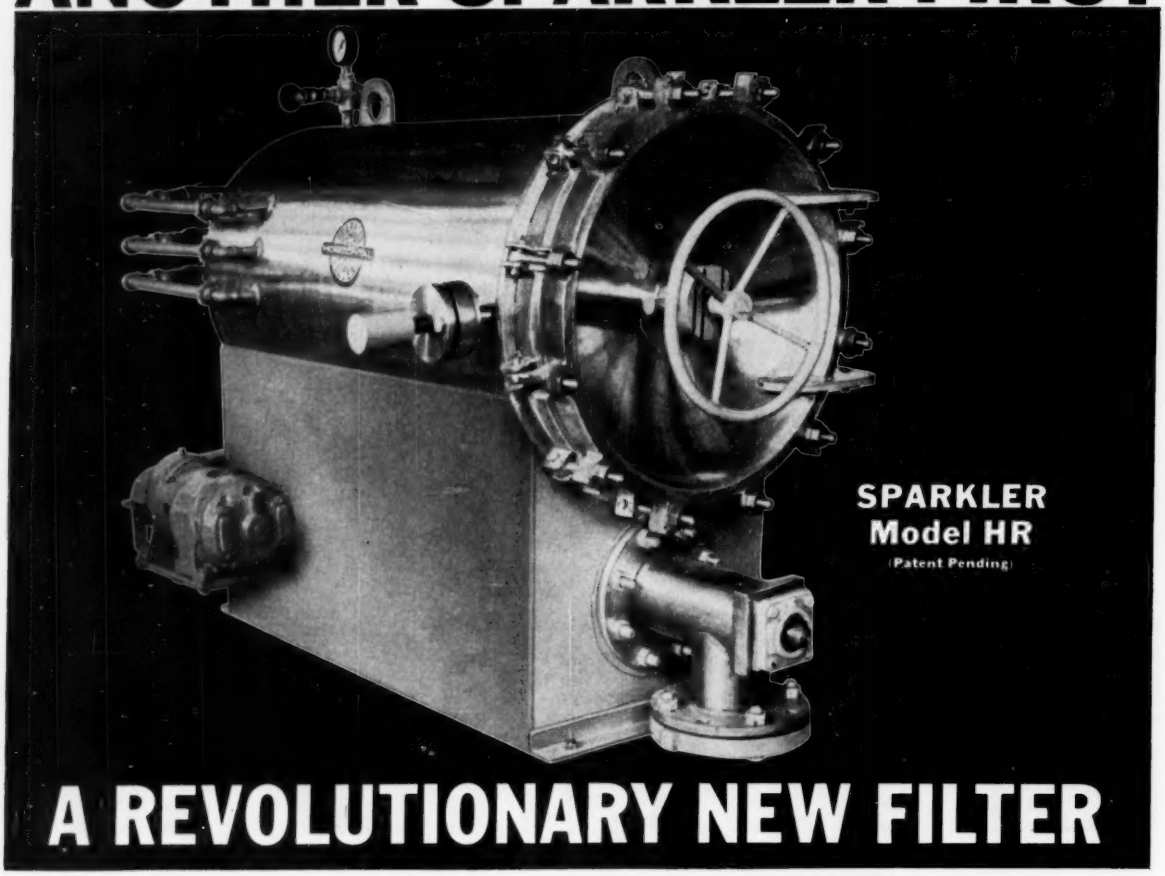

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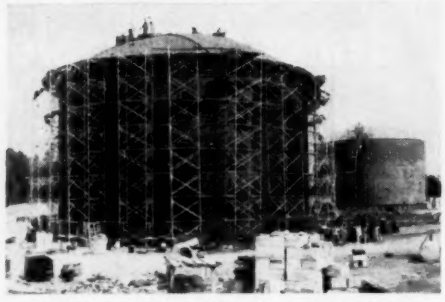
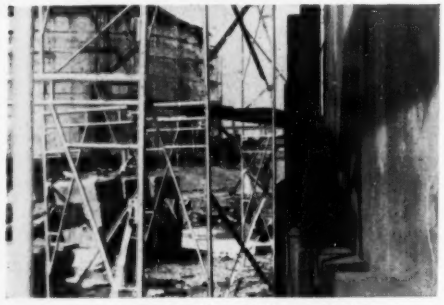


. . . add tank, 70 ft. diameter, 52 ft. high . . .



. . . erect free-standing side insulation . . .

. . . put another 7 in. on tank's roof . . .

. . . tank is insulated; add liquid propane

Low-Pressure Vessel Stores Liquefied Gases

Any way you look at it, 1,297,500 gal. is a lot of propane to store in any one place—far more than practicable for storage in pressure vessels.

Faced with a problem of this dimension about two years ago, Atlanta Gas Light (AGL) put a neat trick to work when it built new propane storage facilities at Riverdale, Ga., to meet peak demands of its gas customers. AGL and its engineers, Stone & Webster, settled on refrigerated low-pressure storage as a means of saving on equipment costs.

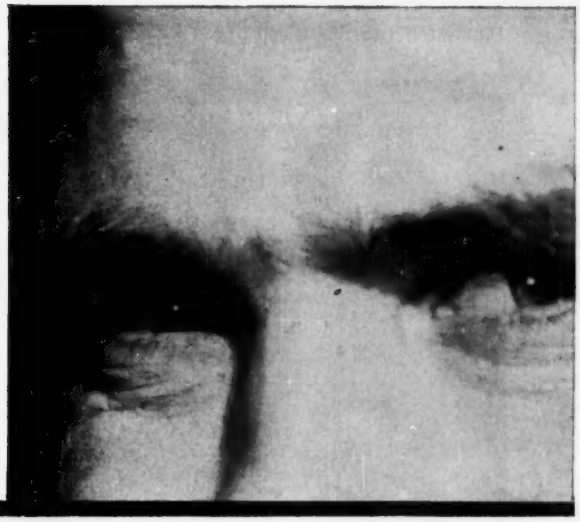
Their decision apparently paid off. Construction of a single tank, capacity 1,297,500 gal., required only 100 tons of steel. To pressure-store this much propane would require some 48 tanks with an aggregate weight of 1,800 tons.

Even when refrigeration costs are thrown in, low pressure storage costs AGL only half that of high-pressure storage—$550,000 (installed cost) vs. $1,130,000. In light of these savings, the company decided to construct two more such vessels of like capacity; these were completed in late 1958.

One of the biggest problems faced and solved was how to insulate the huge tanks at −46 F. If fastened directly to the tank, insulation would separate from the walls when they contracted at the sub-zero operating temperature. If installed apart from the tank walls, it had to be impervious to moisture to prevent condensation and freezing in the annular space.

Spaced ½ in. away from the tank, Pittsburgh Corning's cellular glass insulation, Foamglas, did the required job. The photos above show how it was applied to the tank's bottom, sides and top. Note that in this application, Foamglas's compressive strength enabled it to support not only itself, but also the tank and its contents.

Foamglas insulation also played a part in Rust Engineering's design for three 500,000-gal. Hortonspheres at Alabama Gas's Birmingham facilities. Completed in Nov. 1958, these storage tanks hold propane at 35 F., 57 psi.—**Pittsburgh Corning Corp., Pittsburgh, Pa. 112A**



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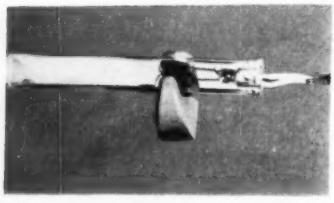


Vacuum Gage

Accurately measures pressure over wide range.

Utilizing the cold-cathode principle of measurment, a new vacuum gage is claimed to have an extremely long operating life, compared with hot-filament gages. Known as the Model 100-A gage, the new unit will measure pressures ranging from 10^{-6} to 10^{-7} mm. Hg. Component instrument parts include the gage tube, power supply, range switch and meter.

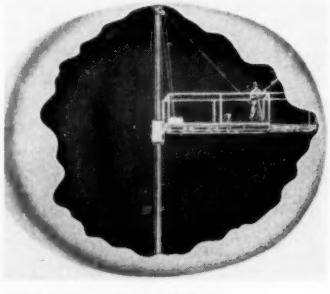
Cold-cathode gages create an electron stream, aligned by a magnetic field, between an anode and cathode within an open-end glass tube. Collision of any gas molecule in the tube with an electron causes ionization of the molecule. Ions collect at the cathode, thus generating a current proportional to the equivalent gas pressure.—**Miller Laboratories, Inc., Brea, Calif.** 114B

Plug Valve

Double-seating valve for wide application.

Called the Wedgeplug "O-Seal," a new nonlubricated plug valve is suitable for service with hydrocarbons, solvents, steam and various gases at temperatures from −300 to 400 F. and pressures to 720 psi. According to the manufacturer, the pressure sealing effect of two O-rings in the plug's face provides absolute, permanent shutoff. "O-Seal" also has a bottom drain plug.

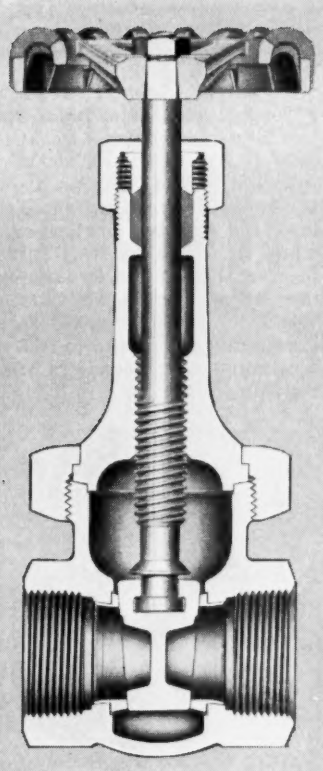
Size range is 2 to 12 in. for 150- and 300-lb. classes; some models are available in the 600-lb. class. User can specify wrench, handwheel or air-cylinder operators. — **Stockham Valves & Fittings, Birmingham, Ala.** 114C



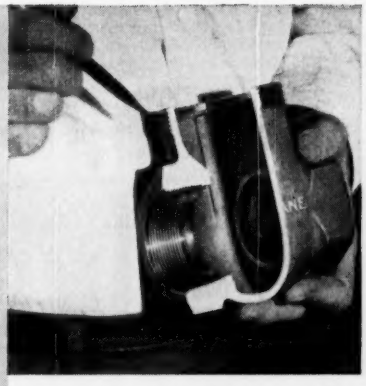
Tank Scaffold

Provides access to all parts of spherical tanks.

Relatively light in weight, a new, all-welded steel scaffold designed for erection within spherical tanks can support up

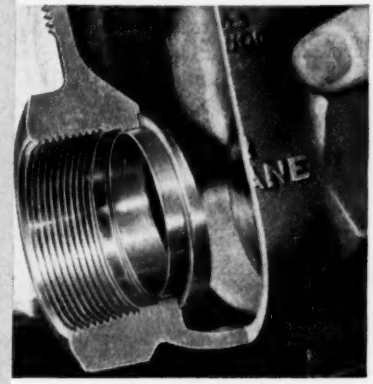


COMPLETELY NEW—loaded with improved service features inside and out. Two complete lines: rising stem pattern (No. 634E—cross section shown), non-rising stem (No. 636E)—both in sizes ¼ to 3 in. incl., with screwed ends. See below for literature.



NEW CYLINDRICAL BODY SHAPE—a proven design on high-pressure steel valves—increases strength without added bulk, distributes pressure load uniformly, resists distortion and leakage at seats.

NEW, STRONGER HEX ENDS, better integrated with body, eliminate sharp contours, give entire valve more rigidity under line strains. Wider hex faces allow firmer wrench grip for easier installation. Marring less likely.



NEW, EXPANDED-TYPE BODY RINGS insure long, tight-seating service life. They're rolled in, can't work loose. Shoulder at bottom of end threads restrains excessive entry of pipe against possible seat damage.

NEW EXELLOY, 12% chromium steel body rings give a hard bearing surface, highly resistant to wear, indentation, scoring and foreign matter damage. Easily replaced bronze disc takes the brunt of normal wear.

New design for tough service...easy maintenance

300-Pound Wedge Disc Bronze Gate Valves

Rising Stem and Non-Rising Stem Patterns

A new body shape that distributes greater strength uniformly against internal stresses and external strains . . . better integrated hex ends, huskier and wider, that add to body rigidity and give a firmer wrench grip . . . new rolled-in, high wear-resisting alloy body rings that don't work loose . . . easily renewed wedge disc—these are typical important features of new Crane bronze gate valves.

On your toughest services, these valves assure ultimate durability . . . new ease of application . . . low-cost repairability. And they're priced no higher than ordinary 300-pound integral seat bronze valves.

Easy to Repair—The Disc Takes the Wear

After long, hard service the hard Exelloy (12% chromium) body rings show no appreciable wear. Normal seating wear is taken by the bronze disc. When needed, a new disc, easily slipped onto stem, provides a practically new, tight-seating valve.

Circular Gives The Facts

For complete technical data on both rising stem and non-rising stem patterns . . . size listing, etc., get Circular AD-2340 from your Crane Representative, or by writing to address below.

CRANE® VALVES & FITTINGS

PIPE • PLUMBING • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Ill.—Branches and Wholesalers Serving All Areas

to 1,500 lb. of personnel and equipment during maintenance operations. Longitudinal sections of the work platform have a telescopic action that enables access to the tank's top and bottom. The entire assembly rotates around a central pole.

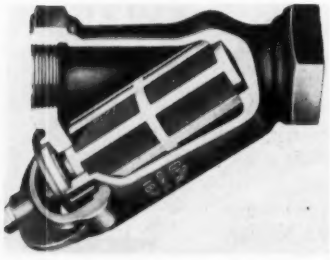
One requirement for this system is that the vertical central pole must be a permanent installation. The balance of the equipment is removable via the bottom manhole. Scaffold can be either hand-, electrically or air-actuated.—**Atlas Industrial Corp., Brooklyn, N. Y.** **114D**

Expansion Joints

Absorb pipe movement in any direction.

Function of a new bellows-type expansion joint is to protect piping systems by absorbing displacement in any direction—axial movement, lateral deflection and angular rotation, either singly or in combination. Known as Zallea universal expansion joints, they come in sizes from 3 to 72 in.

Three different models are offered to cope with a variety of pressure and temperature conditions. Maximum working pressure for the standard line is 2,500 psi.; temperature range is −320 to 1,600 F. — **Zallea Bros., Wilmington, Del.** **116A**



Line Strainers

Made of aluminum for long life, light weight.

New aluminum line strainers for service at pressures to 75 psi. and temperatures to 250 F. are available in ¾- to 4-in. screwed-end sizes. Sizes for 125-lb. flanged ends vary from 2½ to 4 in.

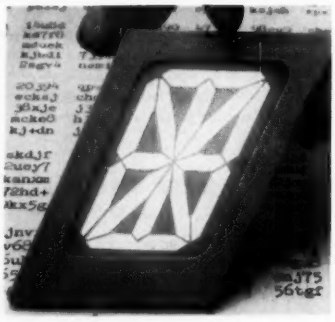
Standard models come with 14- to 80-mesh bronze screens. Woven screens with mesh sizes of 100, 200 and 300 are also offered. — **OPW-Jordan, Cincinnati, Ohio.** **116B**

Explosion-Proof Motors

For installation in any environment.

Totally enclosed, fan-cooled motors capable of withstanding damp, dusty and corrosive atmospheres are available in ¾- to 5-hp. sizes. Having two-, four- or six-pole speeds, the new single-phase machines are built in re-rated NEMA 182, 184, 213 and 215 explosion-proof frames.

Front end heads house the condensers and centrifugal mechanisms, thus providing added protection for these components, as well as cleaner over-all motor appearance.—**Robbins & Meyers, Inc., Springfield, Ohio.** **116C**



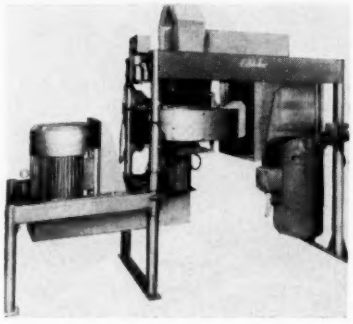
Display Lamps

Print out letters, symbols and numerals.

Research in electroluminescence has led to the development of a new lamp for display of numerical and verbal information. The new lamps—thin, flat, light-emitting plates about the size of playing cards—can each display numerals 0 to 9, all letters of the alphabet and selected symbols. Power consumption is less than 0.2 w. for the largest units.

Electroluminescent light is produced by the action of an alternating field on a film of phosphor. Absence of filaments, gas and mechanical linkages assures a rated life of 3,000 hr.

Visibility is high, even at 50 ft. And, space requirements are low—100 of the smallest-size lamps fit into 3 sq. ft. Offered in several sizes and two styles, the lamps operate on 240 or 460 v. and 60 to 400 cycles. Prices range from $15 to $50.—**Westinghouse Electric Corp., Pittsburgh, Pa.** **116D**



Impact Mill

Reduces particle size to sub-sieve range.

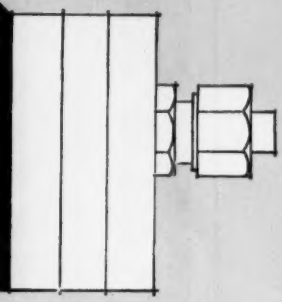
In mid-1958, Entoleter Div. of Safety Industries, Inc. announced development of a prototype impact mill called the ControMil. Since then, several production units have proved themselves in various operations; such commercial models are now generally available.

Within conventional Entoleter impact mills, a spinning rotor throws feed material against a stationary outer wall. In the new Series 27 Contro-Mils, the outer wall revolves in the direction opposite to the rotor, thus compounding impact force and enabling size reductions to sub-sieve ranges.

Particularly suited for non-abrasive, heat-sensitive organic products, the new machines operate at capacities to 9,000 lb./hr.—**Entoleter Div., Safety Industries, Inc., New Haven, Conn.** **116E**

EQUIPMENT NEWS
Continues on . . . **Page 210**

off-the-shelf pumps just right for your requirements



Whatever you want in a pump – for hydraulics, for flow or process control, there is likely to be an Eastern ready-made unit . . . made-to-order for your needs.

CAN YOU USE THESE PUMP FEATURES:

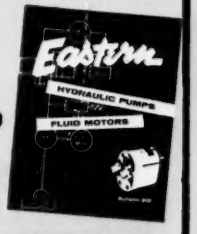
- ☐ corrosion resistant construction for chemical solutions?
- ☐ ability to handle organic and inorganic fluids at various temperatures with flows up to 70 GPM, pressures to 65 psig?
- ☐ available with open, enclosed or explosion proof motors?
- ☐ compact lightweight units with or without motor?
- ☐ high efficiencies in handling hydraulic oil, fuel and lubricants at high pressures?
- ☐ flow rates from 0.1 to 9.8 GPM, pressures from 0 to 1500 PSI?
- ☐ self-priming operation with non-lubricating liquids?
- ☐ high pressure outputs with small, low power units... and no contamination of fluid?
- ☐ flow rates from ½ GPM to 5½ GPM, pressures from 30 to 200 PSI?

An EASTERN CENTRIFUGAL PUMP MIGHT BE JUST RIGHT FOR YOU!

Write for Bulletin 120.

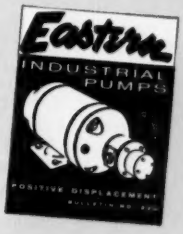
Look into EASTERN HYDRAULIC PUMPS!

Write for Bulletin 810



Get to know more about EASTERN POSITIVE DISPLACEMENT PUMPS!

Write for Bulletin 220.



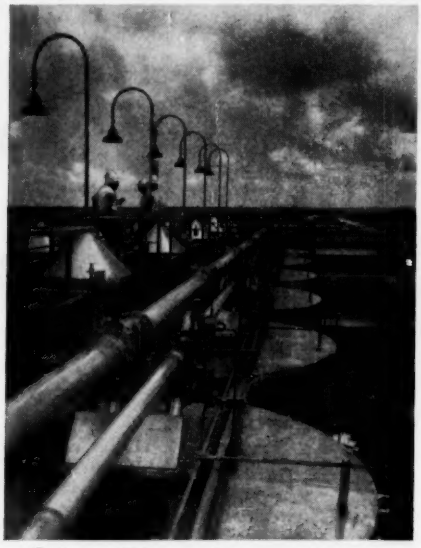
These useful brochures contain full specifications on the complete line in each category, including performance data and tables. They will be sent to you at no obligation whatever. Write Department T.

EASTERN INDUSTRIES PUMP DIVISION ®

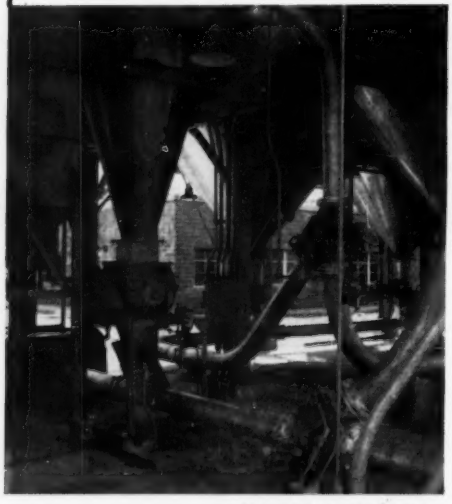
EASTERN INDUSTRIES, INC.

100 SKIFF STREET, HAMDEN 14, CONN.

1. Installation at an ultra-modern plant of one of the largest companies in the chemical field. Shown are storage bins with airtight automatically operated discharge gates.

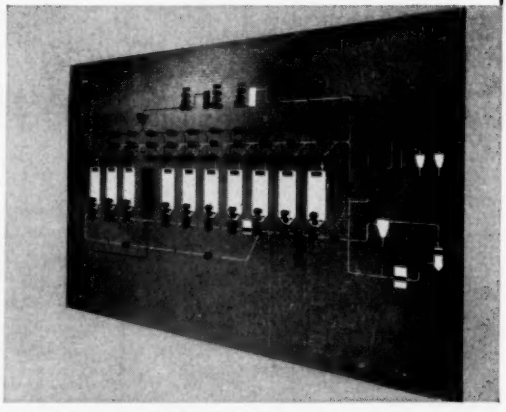


3. Series of bins served by pneumatic conveyor systems with diverter valves.



2. Transfer station, handling polyethylene pellets at rates of 60,000 lbs. per hour, receives materials delivered from any one of several points under vacuum; transfers them to the pressure side of the system for delivery to any one of several discharge points.

4. Graphic control panel built for explosion-proof service. Permits operator to direct flow of materials through proper channels from one central location.



IF YOU PLAN TO HANDLE BULK CHEMICALS DON'T BUY UNTIL YOU CONSIDER

National PNEUMATIC CONVEYORS

If your plant handles fine dry materials in quantity, let National survey your needs and submit a prompt proposal. Chas. Pfizer & Co., Inc., U. S. Rubber Co., U. S. Steel Corp., and many other leading companies have made National their choice. National is equipped to design, build and install your complete pneumatic conveyor system . . . or an addition to your present one. Our testing laboratory is available to determine precise handling requirements for your materials. All this can be done under one contract and one responsibility by a company that can move quickly. Many of the nation's largest chemical companies have returned to National for repeat installations . . . sure testimony to their satisfaction with National's performance. Consult National now . . . write us or our nearest representative listed below.

SEND FOR FREE BULLETIN P58-G
on pneumatic conveyor systems
for handling dry granular materials.

For additional information, consult Chemical Engineering Catalog and Sweet's Catalog

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Also manufacturers of: **National ChipVeyor Systems** for the collection and processing of metal chips and borings and reclamation of cutting oils (send for Bulletin C-56). **Conveyors** for press scrap and small parts. **National Ash Conveyor Systems** for handling ash and fly ash (send for Bulletin P-57A).

REPRESENTATIVES

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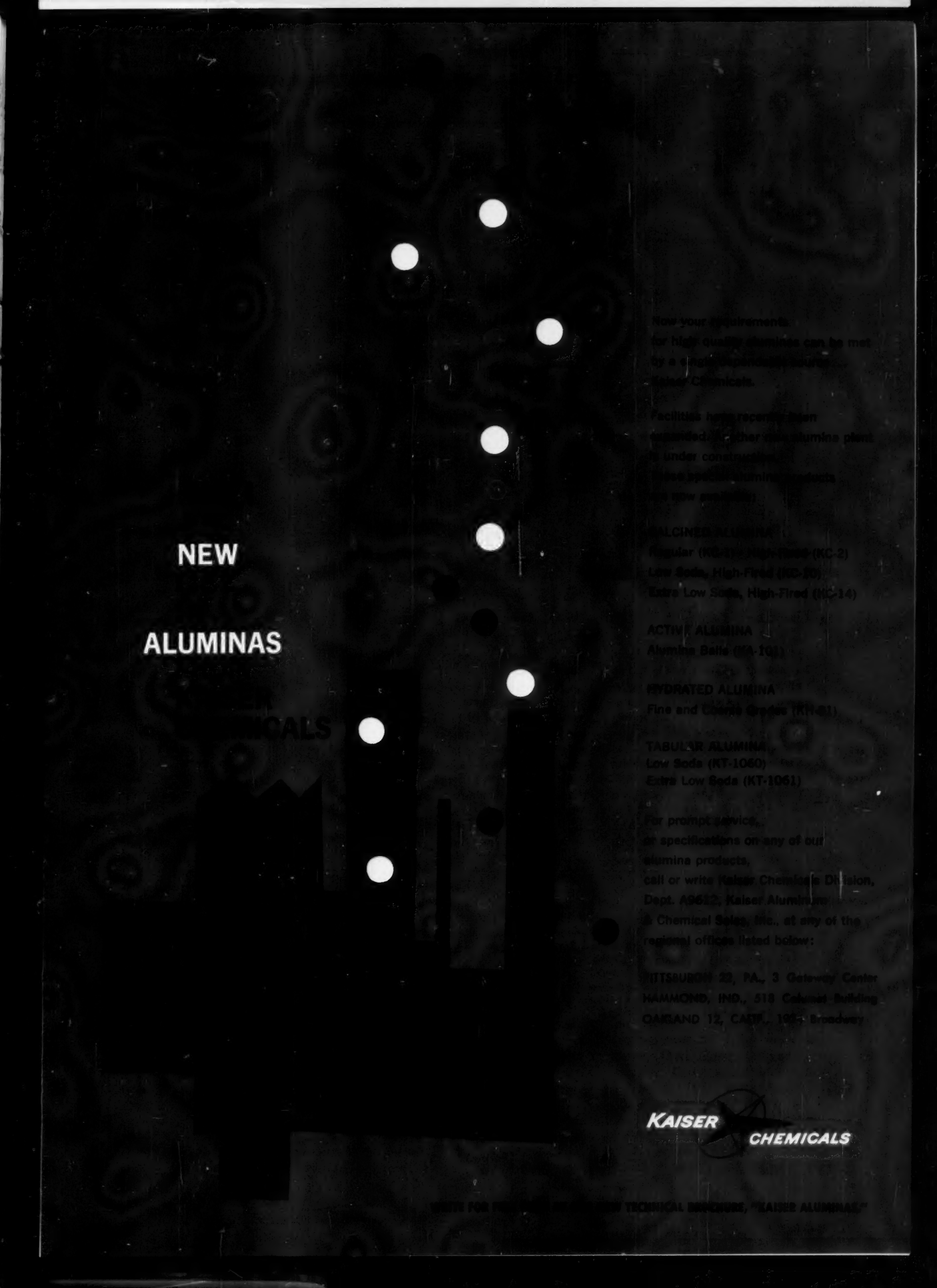
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Now your requirements
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Kaiser Chemicals.
Facilities have recently been
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DEVELOPMENTS . . .

CHEMICAL PRODUCTS EDITED BY FRANCES ARNE

Urethane Foam Now Insulates Refrigerated Trucks

First polyurethene-insulated ice cream delivery truck is shown under construction above. Rigid urethane was chosen because of superior insulation and structural qualities and relative ease of application.

Urethane used has a density of 1.70 with a K factor of 0.17. A commercial grade of glass wool with a density of 2.49 lb./cu. ft. has a K factor of 0.26 and, of course, it does not contribute to structural strength as rigid foam does.

Engineers estimate that, on assembly-line basis, each truck could be foamed in 1½ hr. at less cost than conventional insulation. Equipment used above included a portable mixer with a separate head for remote operation connected to pumps and catalyst resin pots with 50 ft. of hose. — American Latex Products, Hawthorne, Calif. 120A

Epoxy Resin

In adhesives, shows exceptional resistance to impact, temperature change.

A liquid epoxy resin has been developed for uses where continual changes of temperature or heavy impact loads break down the more rigid conventional epoxies.

The resin will find its major markets in adhesive applications — caulking and sealing compounds, body solder, concrete-to-concerte bonds—where changes in temperature tend to weaken bonds. And it can withstand fatigue load and impacts that would shatter the more conventional plastics. Called Epon X-81, it also will be used in making tooling dies and fixtures and encapsulating electrical components.

In liquid stage the resin has a low viscosity—about equal to that of motor oil—which makes it useful in solventless surface coatings. Its flowability also allows it to penetrate deeply into any electrical system being encapsulated.

In the standard elongation tests at room temperature, an Epon X-81 casting doubled its length before it broke (rating 100%), while conventional epoxies snapped at 7% stretch.

Epon X-81 is now selling for 95¢/lb.—**Shell Chemical Corp., New York, N. Y. 120B**

Reinforced Ceramic

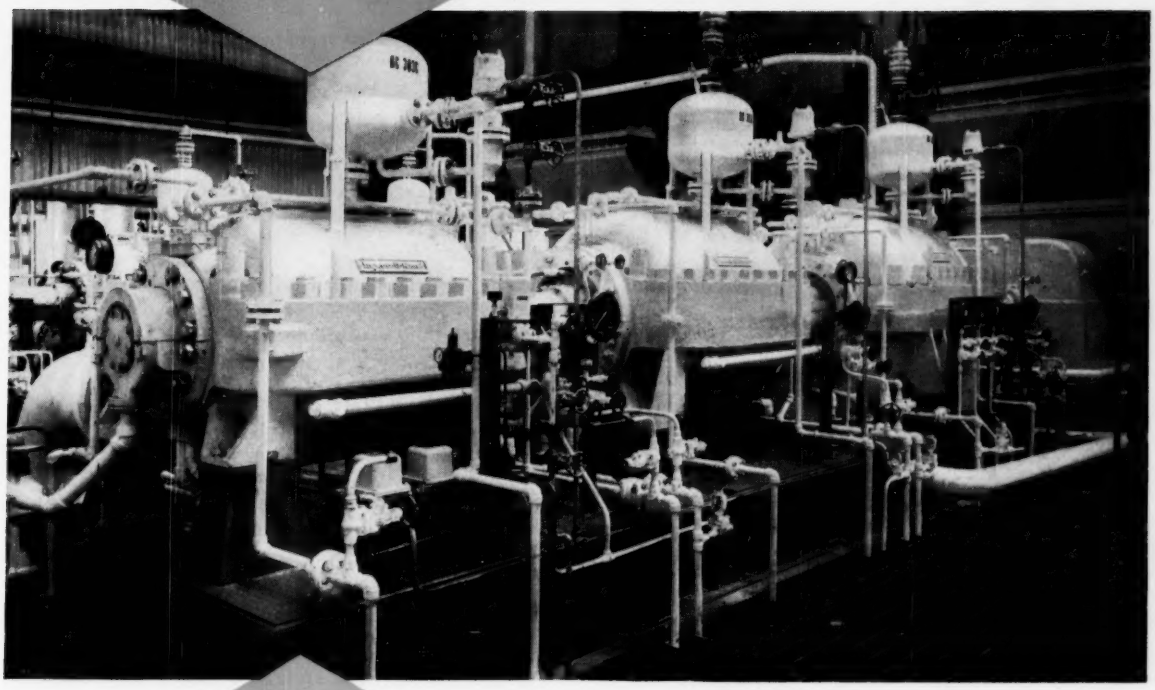
Resists blast of 5,000 F. rocket engine exhaust.

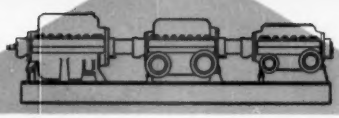
A specially designed and highly developed reinforced ceramic is said to resist gas erosion at extreme temperatures and to eliminate structural failure due to heat shock. Called Avcoite, it is the first of a family of materials basically ceramic in nature using different ingredients in fabrication.

Avcoite can be fabricated for rocket nozzles, nozzle components, and other applications where materials must retain their shape and dimensions at very high temperatures. Negligible changes in rocket nozzle throats have resulted at temperatures of 5,000 F. for test durations of more than 60 sec. with actual rocket motors.

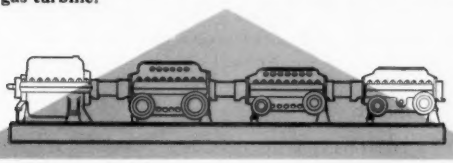
Although the actual nature of the material and its method of manufacture cannot be disclosed, the developers also revealed that failure due to heat shock, which has always plagued ceramic structures, has been eliminated. The normally brittle ceramic has been developed in Avcoite to be quasi ductile. Execessive stresses cause Avcoite to deform rather than result in a brittle, catastrophic fracture. And, the scientists say its resistance to the high-temperature gas erosion caused by liquid and solid propellant fuels used in missile propulsion systems, based on rocket tests to date, has been very encouraging. — **Avco Research & Advanced Development Div., Wilmington, Mass. 120C**

Putting the PRESSURE on Ethylene Production...

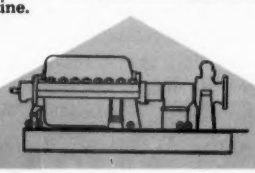




Ethylene Refrigeration: Three multi-stage, horizontally split I-R centrifugal compressors, handling ethylene gas at 396 psig discharge, driven by 12,150 hp gas turbine.



Feed Gas: Four multi-stage, horizontally split I-R centrifugal units compressing 10,750 cfm of hydrocarbon feed gas to 525 psig discharge, driven by 12,150 hp gas turbine.



Propylene Refrigeration: One single-stage vertically split and one multi-stage horizontally split I-R centrifugal compressor handling 17,900 cfm at 265 psig discharge, driven by 12,150 hp gas turbine.

Three Trains of Ingersoll-Rand Centrifugal Compressors help P.C.I. boost ethylene output at Lake Charles plant

THE new plant of Petroleum Chemicals, Inc., at Lake Charles, La., can produce one hundred thousand tons of ethylene per year, making it one of the country's major sources of this vital component for the chemical and plastics industries. Built by the Lummus Company, this P.C.I. plant features the latest technology and equipment for ethylene production.

To handle the various pressures required, nine Ingersoll-Rand centrifugal compressors are installed in three trains, each with its own gas turbine drive. The installation for ethylene refrigeration, shown in the photo above, consists of three multi-stage, horizontally split centrifugal compressors. This and the other two multiple-unit installations, all under one roof, are diagramed at the left. All of these centrifugals are designed to permit a 50% increase in plant production.

P.C.I. facilities at Lake Charles and the adjoining Calcasieu Chemical Corporation's plant (built and operated by P.C.I.) also include two other I-R centrifugals, eleven I-R reciprocating compressors totaling more than 23,000 hp, two I-R Axi-compressors and ninety-two I-R centrifugal pumps.

For information on equipment best suited to *your* compression requirements—centrifugal, reciprocating, axial-flow rotary or ejector—contact your nearest I-R engineer. Sizes and types range from vacuums of 5 microns to discharge pressures of 35,000 psi.

Ingersoll-Rand

12-948 ♥ 11 Broadway, New York 4, N. Y.

COMPRESSORS • GAS & DIESEL ENGINES • PUMPS • AIR & ELECTRIC TOOLS • CONDENSERS • VACUUM EQUIPMENT • ROCK DRILLS

URETHANE foams within epoxy skin in mold for aircraft models.

PILOT-ESCAPE capsules, droppable fuel tank models.

Urethane, Epoxy Team

Now used instead of wood, plastics withstand tumbling, drag less in wind tunnels.

Urethane foam is being used in leading aircraft research and development centers to construct wind tunnel test models having greater adaptability, at lower cost.

The foam may be made flexible or rigid, light or heavy, merely by varying formulations. By deliberately making them too light initially, models are easily weighted where needed, to study effects of inertial distributions. They're used to test wings, bodies and tail sections for flutter and vibration under simulated flight conditions and in design studies of pilot ejection capsules. Replacing balsa wood, previously used for models, the stronger foam withstands tumbling better. The smooth epoxy skin offers less drag than a wooden surface.

At Chance Vought Aircraft, Dallas, Tex., the urethane formulation is poured directly into a mold and allowed to foam around a wooden or metal skeleton. This backbone provides internal reinforcement and rigidity. A fiber glass-epoxy laminate previously layed up in the mold provides the model with a hard, smooth skin for minimum wind resistance. —**Allied Chemical Co., National Aniline Div., N. Y., N. Y.** 122A

Reinforced Plastic

New process forms a glass-like material, "practically indestructible."

Fundamentally classified as a fiberglass reinforced plastic is a specially-developed resin coupled with special glass reinforcement developed by Owens-Corning Fiberglas.

The raw products molded together under pressure and heat are said to form a material that closely resembles glass, but is practically indestructible. For decorative effect, special designs and color patterns are molded into the material, which is being used initially for outdoor trays and table tops.

Called Rexilite, it looks much like glass when molded. It is hard, durable, and resistant to chemicals. It was developed specifically to withstand outdoor climatic conditions indefinitely. It will not rust, rot nor corrode. — **Eubanks Industries, Inc., Hialeah, Fla.** 122B

Plasticizer

Higher in epoxy content by 10%, to 50% less impurities, to 50% lower viscosity.

Said to far outrank quality of other epoxidized soybean oil on the market, yet equal in price, two new plasticizers for vinyl resins are now available.

Called EpoxyGens, they are available in two grades, regular grade 80 and premium grade 90. EpoxyGens feature up to 10% higher epoxy content, up to 50% less impurities, up to 50% lower viscosity and are marketly lighter in color. Nevertheless, EpoxyGen-80—with a guaranteed 85% minimum epoxy content—costs 33¼¢/lb. for bulk tank car shipments. That's precisely the going price for existing epoxy oils offering 75% minimum epoxy content. With a still higher epoxy content than 80, EpoxyGen-90 Sells for 35¼¢/lb., the same price as that on currently available premium-grade oils with 80% minimum epoxy contents.

The PVC-resin stabilizer-plasticizer market is the principal target for EpoxyGens. Measured as a 20-25-million-lb./yr. outlet, this application represents by far the largest market for epoxy oils.

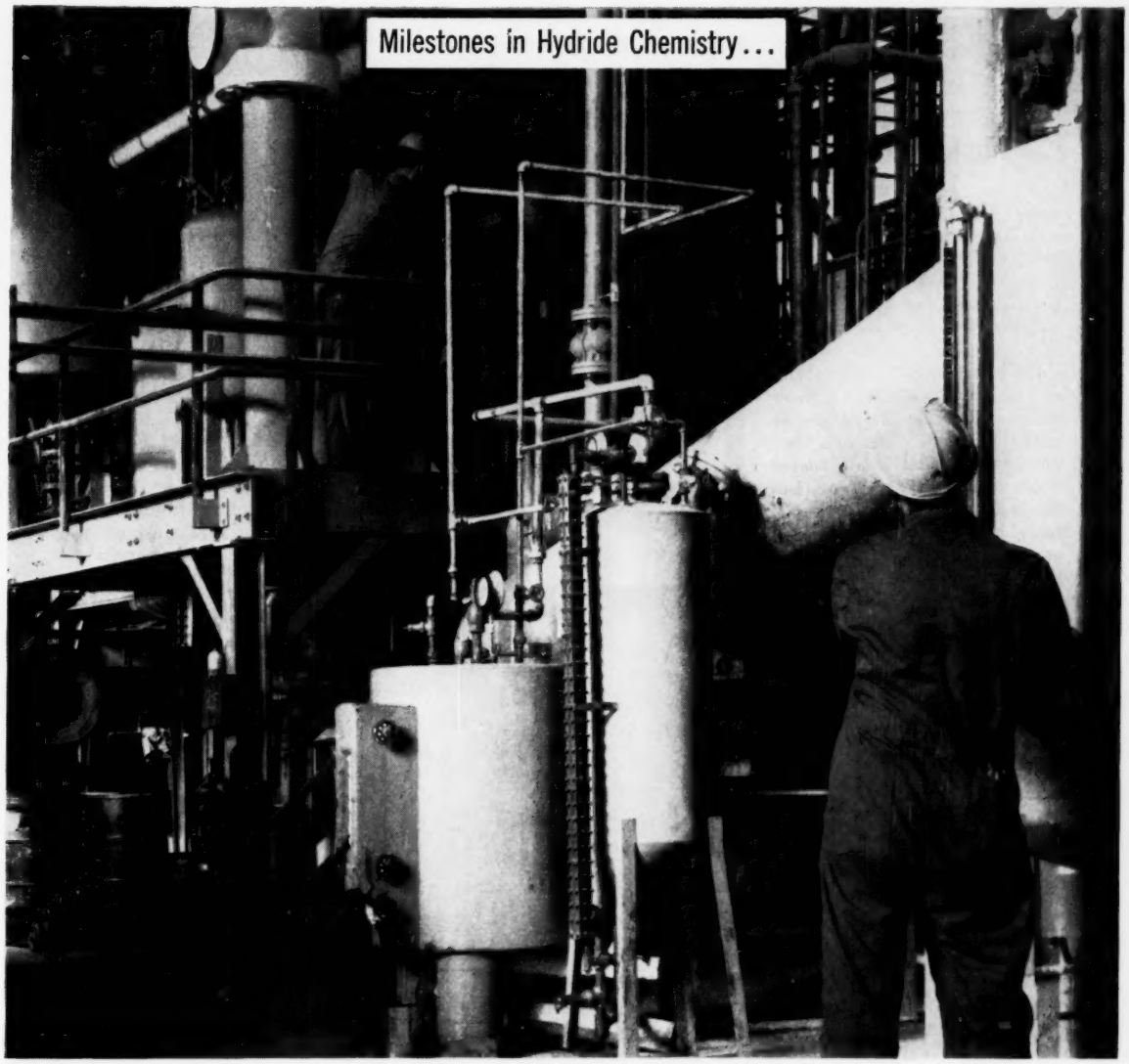
EpoxyGen is more compatible

Newsworthy Chemicals

Page Number is also Reader Service Code Number

Urethane foam now insulates refrigerated trucks..... **120A**
Epoxy resin makes adhesives stand impact, temperature **120B**
Reinforced ceramic takes 5,000 F. blasts..... **120C**
Urethane-epoxy team improves aircraft models..... **122A**
"Indestructible" glass-like material is reinforced plastic **122B**
Epoxidized soybean oil boasts higher quality, lower price **122C**
For molding: Glass fabric impregnated, then chopped.. **124A**
Silicone lets insulating varnish cure 100 C. lower..... **124B**
Fire-resistant hydraulic fluids for heavy duty..... **124C**
Polyethylene wax of low mol. wt. is versatile modifier.. **124D**
Antiozonant gives longer protection..... **124E**
Asbestos fiber offers unusual whiteness, low iron..... **124F**
Tertiary fatty amines are commercially available..... **124G**

For more details, use Reader Service Card



MHI Sodium Hydride Production Hits New High
Large Quantities Available-Fast!
Technical Service Assistance Also Available

Recent expansion of MHI's Beverly plant has made production quantities of sodium hydride available from stock. This is important news if your process includes any reaction currently requiring a base as a reagent.

Yields and reaction times are improved because of the greater reactivities of the hydride. Processing is improved because the 50% dispersion of sodium hydride crystals in mineral oil can be handled without danger and can be packaged to your unit specifications. Reaction control is easy and accurate.

Samples and detailed data on the use of MHI sodium hydride will be sent by return mail or if you desire, MHI Technical Service representatives would be pleased to visit your plant to discuss the use of sodium hydride in your process.

CHEMICAL HYDRIDES DIVISION
Metal Hydrides Incorporated
PIONEERS IN HYDROGEN COMPOUNDS
323 CONGRESS STREET, BEVERLY, MASSACHUSETTS

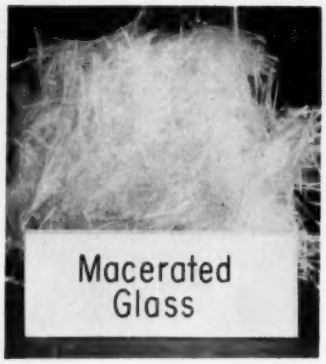
For Molding: Glass Fabric Impregnated; Chopped

A new macerating process makes possible a new line of molding compounds said to offer greater strength, higher temperature resistance, and to add greatly to ease of application in molding, either by compression or by transfer system.

Pre-impregnated glass fabrics are chopped to short fibers which still retain the properties added by the impregnation. Process yields individually coated fibers which fall readily into isotropic distribution in the finished form, providing maximum and uniform strength throughout the finished part.

Available in a wide variety of resin systems, the compounds have a glass content as high as 70%. Relatively high in cost, they can be had in both Standard "E" glass and high silica content glass.

Some of the compounds have been tested to prove heat resistant to temperatures of 20,000 F. for short duration applications. — Coast Mfg. & Supply Co., Livermore, Calif. 124A



with vinyl resin than lower-grade epoxy oils, thus allowing an increased amount of the stabilizer-pasticizer to be milled with the resin. One result is that compounders can turn out products with 20-40% greater heat stability by using Epoxy-Gen. Furthermore, it markedly reduces the tendency of resins to spew, an aging phenomenon where particles separate out and ruin vinyl products due to air and light exposure. Lighter color permits better coloring of vinyl resins; greater purity results in higher quality vinyl products.

A number of new and promising applications are appearing that could develop into substantial markets. Research work in England and the U.S. indicates that the presence of epoxy oil improves the corrosion resistance, adhesion and gloss of alkyd-resin type paints. Du Pont studies on the substitution of epoxy oil and urea-formaldehyde resin for alkyd resin in the manufacture of nitrocellulose lacquer points out that this improves the adhesion, impact and solvent resistance of such lacquers.

Responsible for the Epoxy-Gens' combination of high quality and low price is a new process for epoxidizing unsaturated vegetable oils and fatty esters. It went into commercial use at a Minneapolis plant last fall. A second plant is due on stream next year.—**General Mills, Inc., Minneapolis, Minn. 122C**

BRIEFS

Low-temperature curing silicone resin cuts by as much as 100 C. the temperature required for curing electrical equipment insulated with silicone varnishes. It is called XR-622 silicone impregnating resin.—**Silicones Div., Union Carbide Corp., New York, N. Y. 124B**

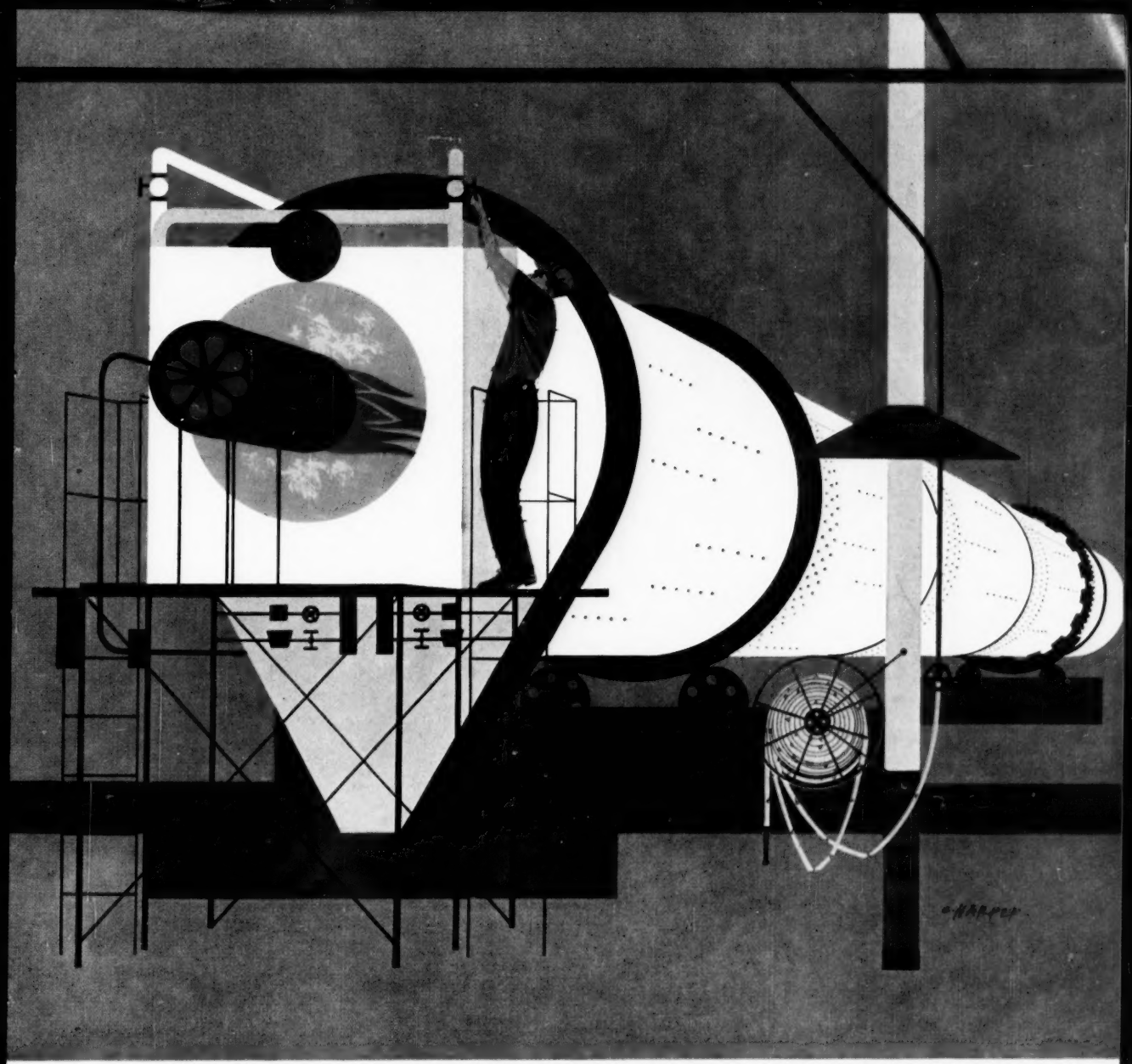
Fire-resistant hydraulic fluids, Mobil Pyrogard Nos. 42, 43, 53 and 55, are now available for use in heavy-duty installations involving radial-piston pumps and high pressures.—**Socony Mobil Oil Co., New York, N. Y. 124C**

Polyethylene wax of low molecular weight has been developed as a modifier for paraffin and as an additive for rubber and plastics, as well as an ingredient in polishes.—**Eastman Chemical Products, Inc., N. Y., N. Y. 124D**

Antiozonant called Wingstay 100, recently introduced, is said to protect rubber against ozone over longer periods. Like most other antiozonants, it is a paraphenylene diamine; unlike them, it is not a dioctyl or diphenyl derivative. It is said to have better solubility in rubber and more can be put into a formulation. Also, it blooms at a slower rate.—**Goodyear Tire & Rubber Co., Chemical Div., Akron. 124E**

Asbestos fiber of unusual whiteness, low iron content, low grit content and uniform fiber length is now available in commercial quantities. Called 7RF-7, it is expected to be important to resin compounders, joint cement manufacturers and others seeking an air chamber asbestos float with the above properties.—**Philip Carey Mfg. Co., Lockland, Cincinnati, Ohio. 124F**

Tertiary fatty amines and related chemicals, symmetrical and non-symmetrical, are now being made commercially thanks to a unique company-developed process. Because of unusual selective attraction properties of the amines, they have proven successful in the separation of uranium from its ore. Similar application in the extraction of other metals from ores is anticipated. — **Archer-Daniels-Midland, Minneapolis, Minn. 124G**



Gigantic rotary kilns at Morton plants can dry 35 tons of salt an hour. 350°F. heat removes moisture before salt is screened and stored.

Only Morton offers salt service to industry everywhere in America

Morton, the only nation-wide salt company, has salt sources, sales offices and warehouses from coast to coast. This means Morton can offer you complete salt service whether you have just one plant or several plants in different states.

To tailor-make salt for the many special needs of industry, Morton starts with salt of natural high purity from one of its sources. With the help of gigantic refining, drying and screening equipment, plus constant quality checks, Morton can produce and package salt to meet exacting specifications for any user—from huge chemical plants to small neighborhood bakeries.

Morton produces nearly 100 different grades of salt for industry. Morton delivers salt by boat, barge, truck and rail. This means you can get fast delivery on a bag to thousands of tons, anywhere in the country.

Morton sales representatives are backed by the services of their own ultra-modern salt research laboratory—the most complete laboratory of its kind in the world. This means you can get complete technical assistance on any problem relating to salt. This service help alone may be worth thousands of dollars to you every year.

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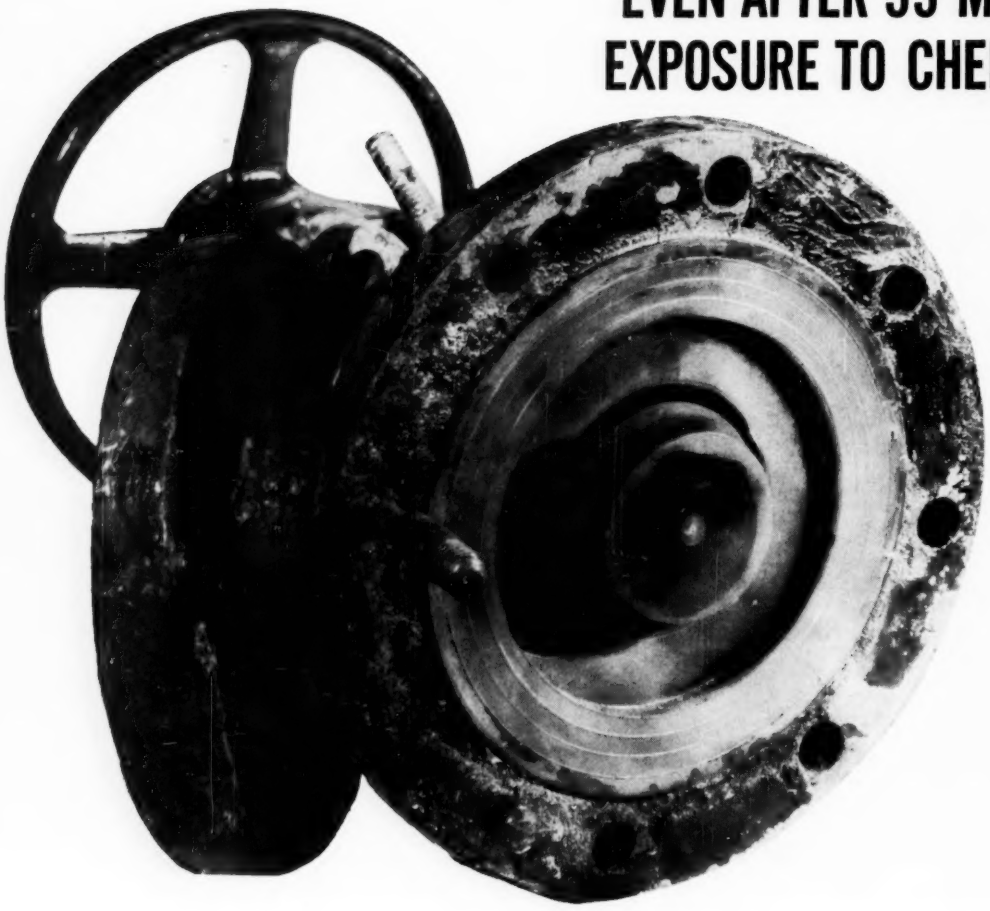
HERE'S PROOF THAT PENTON* RESISTS CORROSION EVEN AFTER 33 MONTHS' EXPOSURE TO CHEMICALS



Hercules Powder Company
900 Market Street
Wilmington 99, Delaware

Please send me literature on the properties and uses of Penton and "The ABC's of Penton for Corrosion Resistance."

*Name*_____

*Title*_____

*Company Address*_____

_____

Shown above is an unretouched photograph of a 2-inch William Powell Y-Valve after 33 months of continuous service under highly corrosive conditions. Placed in service in September, 1955, in the inlet to the hydrochloric acid transfer pump in a chemical plant, the valve was removed in June, 1958, when a leak occurred in the gasket at the spool piece connection. The Penton lining and plug are as good as new. Service conditions involved 30 to 33% HCl from 0 to 35°C.

Such "proved in action" case histories are not unusual for Penton—the new thermoplastic polymer with exceptional corrosion resistance. Valves, pipe and fittings, pumps and meters, flame sprayed or whirl sintered metal parts—all are now available with the extra protection only Penton can provide.

To learn more about Penton, write for your copy of "The ABC's of Penton for Corrosion Resistance" and the technical brochure on the properties and uses of Penton. Whether you make or use processing equipment you'll find that Penton may well be the answer to many of your corrosion problems.

**Hercules Registered Trademark for Chlorinated Polyether*

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CP58-9

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The Chemical Engineer Nurses 5,000,000 Babies A Year

Miracle drugs, vaccines, general pharmaceuticals . . . safeguards for a better, longer life made possible by the chemical engineer and his technology.

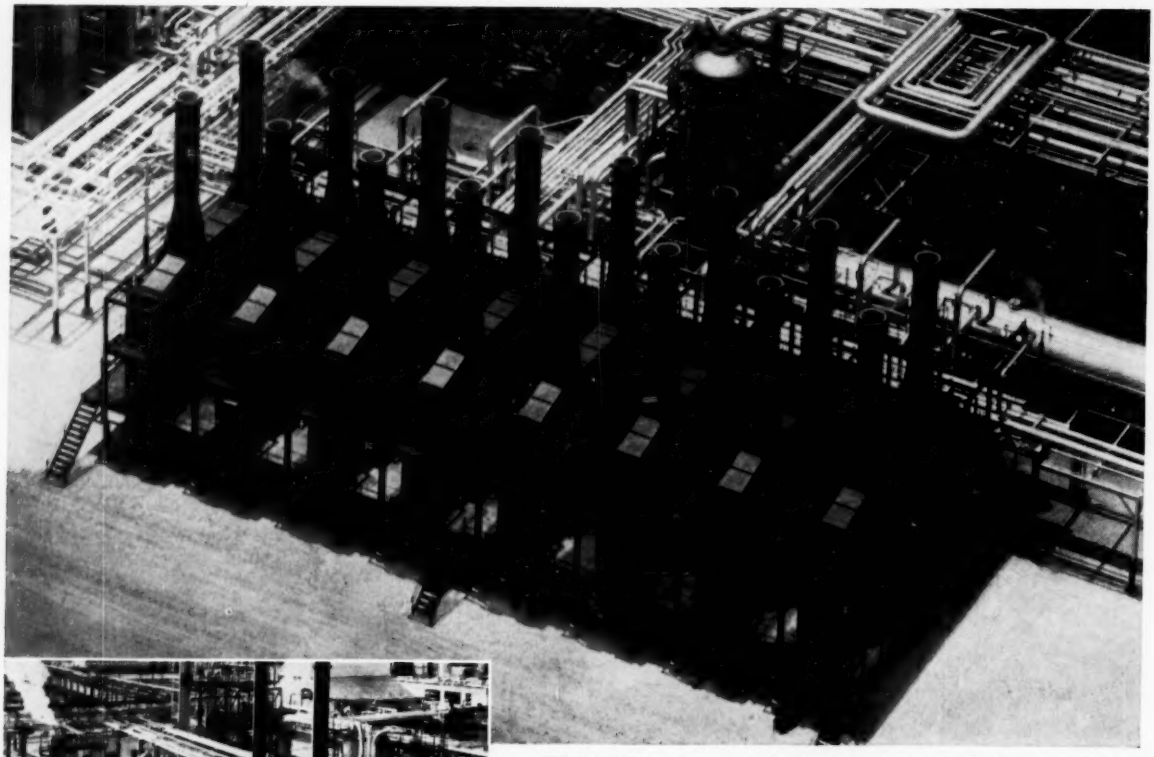
Wherever the chemical engineer appears in industry — in the familiar Chemical Process Industries from fertilizers to pharmaceuticals, and ever reaching beyond — he is a key buying pivot. To solve plant problems, he instigates orders, specifies raw material and equipment required. He develops products and processes, designs and builds plants and keeps them operating profitably. He is your *first* sales target.

For 55 years of industry growth and expansion, CHEMICAL ENGINEERING has maintained its sharp editorial focus on this man, wherever he is, whatever he does. It's the solid 3 to 1 choice among chemical engineers in all functions, in all industries. Now they get it *more often*, spend *more time* with it . . . Starch "Noted" scores are up 11.3%, "Read Most" scores up 28.7%, inquiries up 15.5% over 1957's monthly issues. CHEMICAL ENGINEERING, a McGraw-Hill Publication, 330 W. 42nd St., New York 36, N.Y.

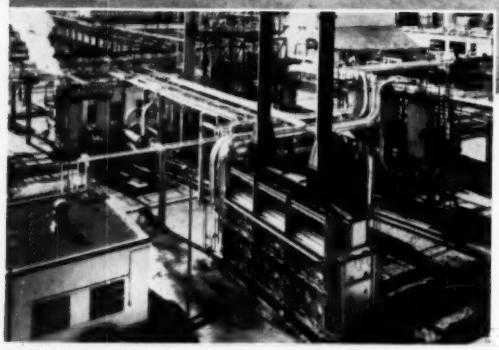
Published every other monday for Chemical Engineers in all functions

our research is your reward

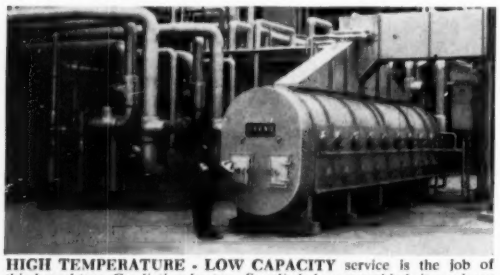
SELAS Gradiation®: heat processing for the petroleum, petrochemical and chemical industries



ETHYLENE is produced in this battery of 8 Selas Gradiation heaters. Each individual heater is capable of handling a variety of feed stocks such as ethane, propane, butane and naphtha. This installation has been in continuous service for more than 4 years.



CATALYTIC REFORMING requires a tight plot plan to keep costly transfer piping to a minimum. The Zone Control of this Gradiation heater makes possible the installation of 3 coils in a single box, all capable of independent temperature control.



HIGH TEMPERATURE - LOW CAPACITY service is the job of this barrel-type Gradiation heater. Supplied shop-assembled, it produces superheated steam in 2 separate coils ranging from 1000° to 1250°F.

Throughout the petroleum, petrochemical and chemical industries, the Selas Gradiation principle of direct-fired radiant heating brings to critical processing operations:

- Preciseness of heating
- Zone Control
- Instant response to controller demand
- Versatility

In addition, where heat capacities are small . . . even for low temperature, non-critical applications . . . barrel-type Gradiation heaters, offering all the benefits of Selas radiant heating, are competitive.

For information about Selas Gradiation heaters send for Bulletin 133 "Gradiation Heating for Petroleum and Chemical Processing." Selas engineers will be glad to discuss with you your specific heat processing requirements.

Gradiation is a registered trade name of Selas Corporation of America.

SELAS CORPORATION OF AMERICA DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers

DEVELOPMENT • DESIGN • CONSTRUCTION

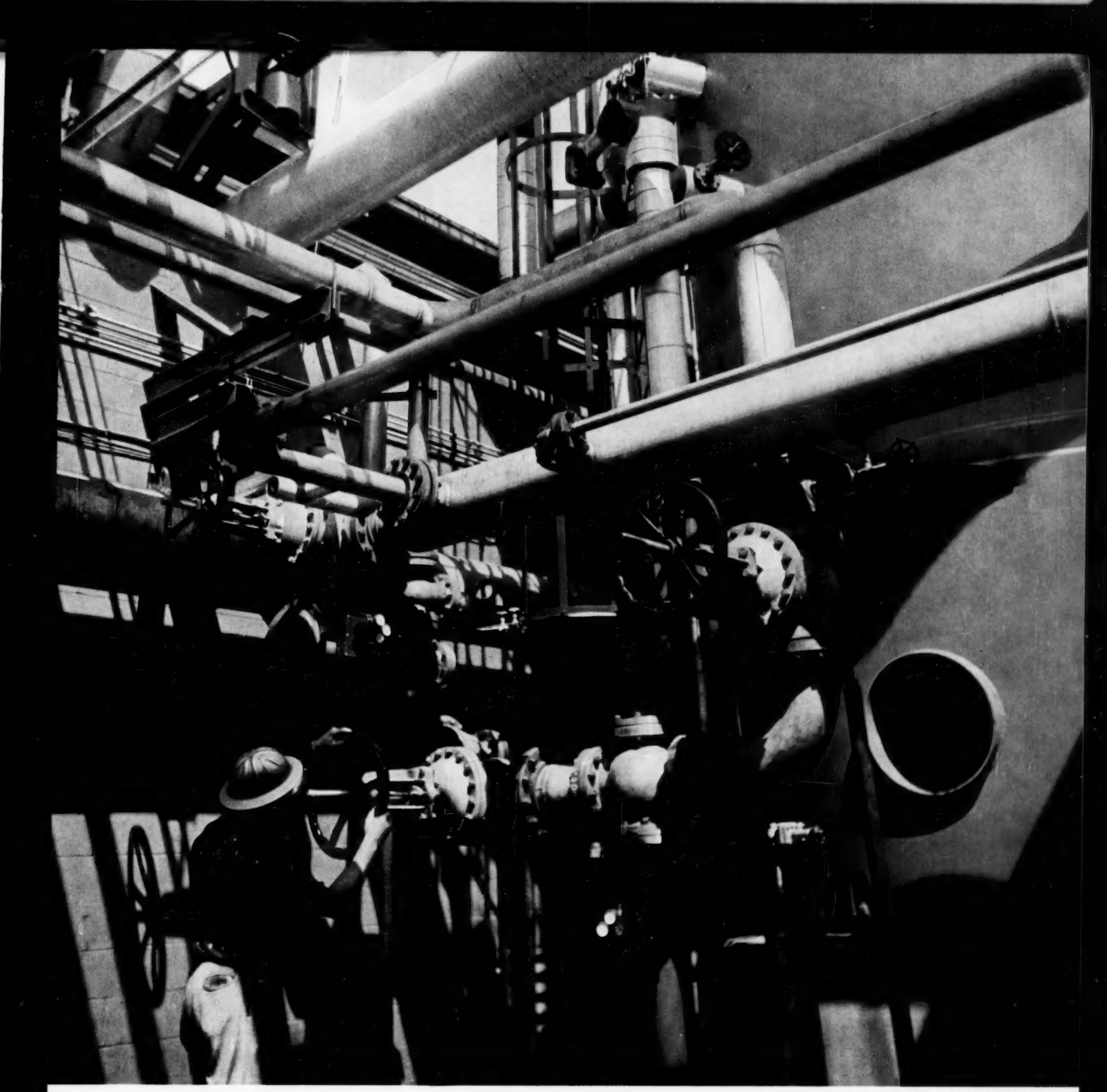


PHOTO ON ANSCOCHROME

SPECIAL PROCESS... General Aniline & Film Corporation's new plant at Linden, N. J., went on stream last year. Built by Scientific Design Co., Inc., it produces ethylene oxide by direct air oxidation of ethylene, Scientific Design's own efficient and economical process. The Aloyco Stainless Steel Valves here (red hand wheels) were selected for their design features and long life expectancy. On your next stainless steel valve job, why don't you talk first to the one company which specializes in high alloy valves exclusively. For further details about Aloyco Valves, write us at 1301 West Elizabeth Avenue, Linden, New Jersey. 9.5

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The powerful, compact LGP-30 provides you with fast, accurate answers in all types of statistical studies – analysis of variance, regression analysis, etc. – also allows you to optimize heat exchanger, distillation column and other equipment design. Other important CPI jobs include mass spectrometer analysis and refinery process simulation. Solutions are printed out in any desired alpha-numeric format – require no deciphering. Result: the LGP-30 relieves you of the tedium of detailed calculation . . . allows you to handle more assignments . . . frees your time for further creative work.

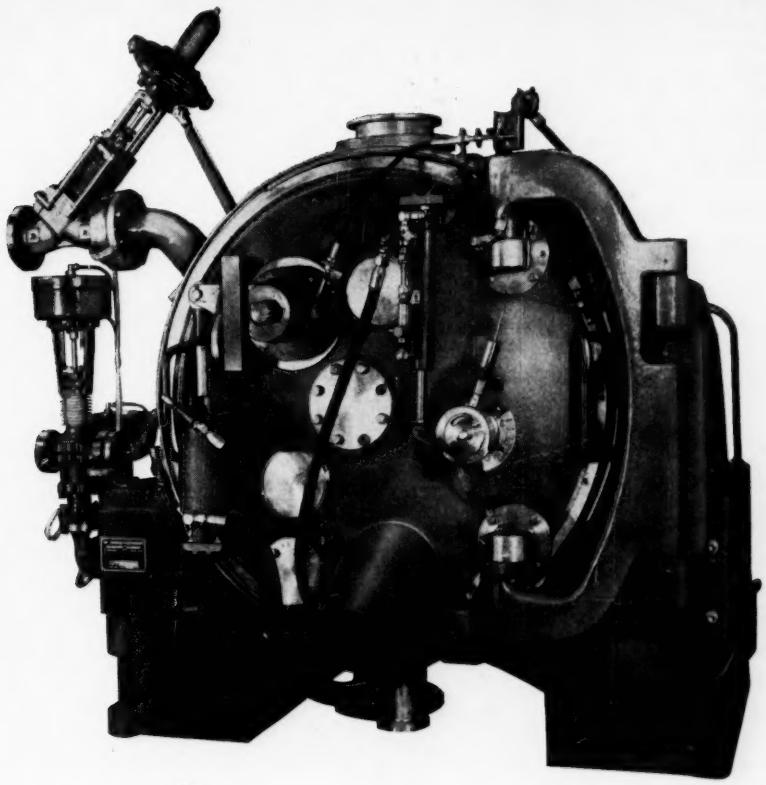
The LGP-30 offers you capacity comparable to computers many times its size and cost. It has a magnetic drum memory of 4096 words and is by far the easiest computer to program in basic machine language. The LGP-30 operates from any convenient wall outlet . . . requires no special installation or air conditioning. Auxiliary high-speed input-output equipment is available for increased operational speed.

Backed by 20 years of electronics experience, LGP-30 sales and service are available through Royal McBee offices coast-to-coast. Customer training is free. An extensive library of programs and sub-routines is available (including Box technique for experimental design) – as well as membership in an active users organization.

For further information and specifications, write Royal McBee Corporation, Data Processing Division, Port Chester, N. Y. In Canada: The McBee Co., Ltd., 179 Bartley Drive, Toronto 16.

ROYAL McBEE • *data processing division*

The new Sharples C-41 Super-D-Hydrator



Another Sharples Exclusive

Easily Handles Polyolefins and other difficult Purifications

Slow draining compressible fine solids . . . high purity essential . . . segregation of rinse liquor from mother liquor required . . . multiple washing with various rinse materials . . . volatile mother and rinse liquor . . . continuous operation under pressure . . . high capacity . . .

The C-41 Super-D-Hydrator is the centrifuge that meets the stringent requirements of polyolefins and similar materials.

By applying high centrifugal force to a thin layer of crystals, and by controlling exactly the thickness of the cake, compaction is prevented and the crystal layer quickly gives up its liquid content . . . maximum use is made of rinse liquors in minimum time . . . because washing rinses are applied sequentially, separation of the mother liquor from various wash materials such as hydrocarbons, water, solvents, etc., is readily accomplished in the effluent piping . . . volatile materials are handled in the pressurized design without loss or hazard . . . controlled high speed unloading efficiently handles the pure, dry crystals and automatically prepares the basket screen for the next load . . . capacity on polyolefins is from 1 to 3 tons of dry solids per hour (up to 24 tons/hour in such materials as free draining ammonium sulphate).

The C-41 Super-D-Hydrator has been designed with the future in mind . . . and is proving today its exceptional performance on production lines in the field.

If high purity and increased capacity at minimum operating cost are requisites, let us tell you how the Super-D-Hydrator fits into your plans.

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Operating efficiency goes **up** . . . costs **down** when Carpenter Stainless Condenser Tubing goes in

PROVING GROUND—Partial view of 40,000 sq. ft. main surface condenser where superiority of Carpenter Stainless Tubing has been demonstrated by extensive tests under actual operating conditions.

• Comparative tests under severe operating conditions prove Carpenter light-wall stainless tubing is a key to improved efficiency in power plant operation. Its superiority has been demonstrated in brackish, highly acid and other low ph circulating water conditions. In the main condenser of a large Eastern utility, exhaustive checking and re-checking of comparative performance over a 3-year span verifies these important advantages:

longer tube life • greater resistance to erosion • more resistance to scale and corrosion • better heat transfer than published rates • greater and faster thru-put of cooling water • higher strength to weight ratio • improved tube cleanliness, less cleaning • lower tubing costs

Data compiled from these extensive tests are available to your engineering staff as a help in solving your tubing problems in power plant equipment. Technical assistance in tube selection and installation is available through our nearest office. Or write to The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

your master key to cost savings in power equipment

Carpenter

Stainless Tubing & Pipe

. . . DRY JET FUELS

Jet aircraft now get a new and wider safety margin when their fuels are dried with LINDE Molecular Sieves. Even at high fuel flow rates, water normally absorbed at ground level is reduced to less than 10 ppm—eliminating ice-blocked fuel lines at high altitudes.

Liquids never before dried successfully by desiccants can now be dried commercially with these new zeolite adsorbents. Examples are acetone and other ketones, ethanol and other alcohols, and most saturated and unsaturated hydrocarbons. Drying to less than 1 ppm is now practical in dynamic systems. Due to their high water adsorbing capacity, LINDE Molecular Sieves bring pronounced savings in investment and operating costs.

No matter what the liquid—whether attempts to dry it have succeeded or failed—we would like to discuss with you what a Molecular Sieve design can do. Write Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y. In Canada: Linde Company, Division of Union Carbide Canada Limited.

Linde UNION CARBIDE

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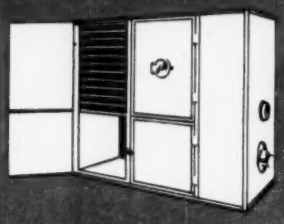
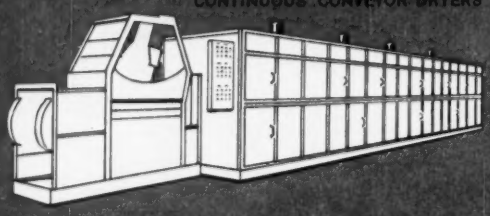
WHAT'S BEHIND...

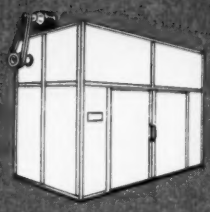
TRAY DRYERS



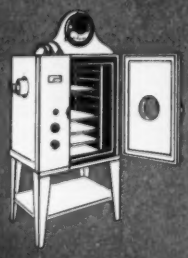
CONTINUOUS CONVEYOR DRYERS



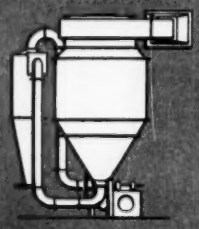
TRUCK DRYERS



LABORATORY DRYERS



SPRAY DRYERS



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Cost cutting ideas in **TITANIUM**

24" dia. impeller fabricated from Mallory-Sharon commercially pure titanium. Diagram shows application in gas scrubbing system.

TITANIUM IMPELLER PROVED "BEST BY TEST"

...outlasts other metals more than 40 to 1

CORROSION TEST DATA
Results after 16-day exposure

MATERIAL	CORROSION RATE INCHES/YEAR	COMMENTS
Pure Titanium	0.0006	No visual effect
Pure Zirconium	0.027	Slight pitting
Nickel-Base Alloy "A"	0.052	Slight uniform corrosion
Nickel-Base Alloy "B"	0.206	Sample etched
Nickel-Base Alloy "C"	0.217	Sample etched
Nickel-Base Alloy "D"	5g. Sample consumed	
300 Series Stainless "A"	0.442	Sample deeply etched
300 Series Stainless "B"	0.510	Sample deeply etched
Nickel-Copper Alloy	50g. Sample consumed	
Nickel	55g. Sample consumed	
Metallic Silver	.20% Gain in Weight	

Approximate conditions of test: *Temperature*—40° to 90°F., *Humidity*—atmosphere more than saturated; *Primary corrosive agents*—Hypochlorous acid, Hydrochloric acid, Sodium Hypochlorite, Caustic Soda, Free Chlorine.

A leading chemical company faced a serious problem in a multi-metal chloride "gas scrubbing" system. The system's high-velocity blower, handling corrosive wet gases at 40° to 90°F., operated at 3500 rpm. Peripheral speeds were too high to use a plastic coated steel impeller. When one was tried, it lasted just two days.

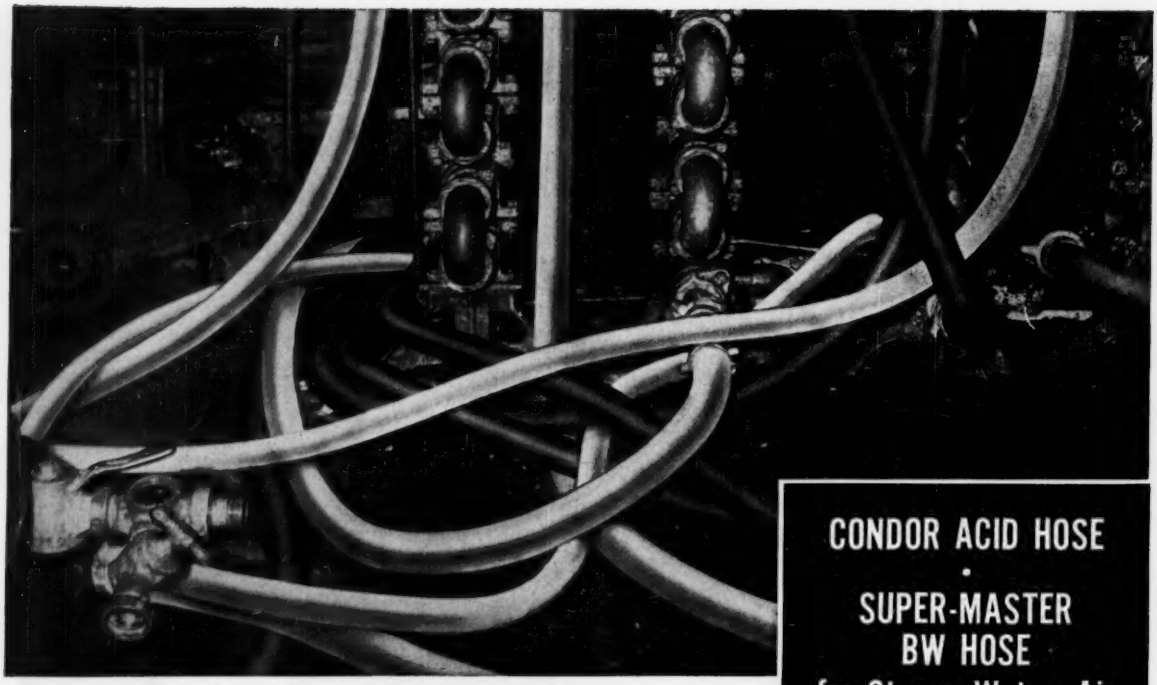
Titanium was then considered with other metals, and evaluation tests run that proved titanium was by far the best. (See test results at left.) An impeller fabricated from Mallory-Sharon commercially pure titanium was installed. To date, it has given *10 months' continuous service* and is still in use. And *the original cost was no more* than for a nickel-base alloy impeller.

We'll gladly help you in applying titanium for highly corrosive service. For further information, write for "Cost Cutting Ideas in Titanium for Chemical Pumps, Valves and Accessories". Address: Commercial Market Development, Dept. B, Mallory-Sharon Metals Corp., Niles, Ohio.

MALLORY SHARON

MALLORY-SHARON METALS CORPORATION · NILES, OHIO

Integrated producer of Titanium • Zirconium • Special Metals



R/M HOSE
Engineered for Chemical Processing

Engineered features of Raybestos-Manhattan hose for the chemical industry increase hose service life for every job requirement. Condor Acid Hose, for example, can handle practically all inorganic acids and salts up to 150° F. It is available with special tubes of rubber, neoprene, Butyl or Hypalon to withstand a wide variety of active chemicals. Super-Master BW Hose with woven wire reinforcement is practically burst-proof, ideal for handling steam, air and water under high pressures. R/M Teflon* Lined Hose assures complete resistance to most active corrosive and contaminating solutions, prevents caking of hose lines. Raybestos-Manhattan also manufactures special types of oil-proof hose for petro-chemical processing.

For general service at the chemical plant, Allflex is light, strong, and flexible as a rope . . . the easiest handling all-purpose hose made for use with air, water, oil and gases—even mild chemicals.

Where corrosion, wear, or expansion are problems with metal pipe, use Condor Flexible Rubber Pipe that outlasts iron or steel. R/M Rubber Expansion Joints are engineered to prevent stresses of expansion, misalignment, and insulate vibration.

For every application in the chemical industry, there's an R/M hose or Condor Flexible Rubber Pipe to do a better job, longer . . . give you "More Use per Dollar." Discuss your requirements with an R/M representative.

CONDOR ACID HOSE

•

SUPER-MASTER BW HOSE for Steam, Water, Air

•

R/M TEFLON* LINED HOSE

•

ALLFLEX ALL PURPOSE HOSE

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PARANITE OIL-PROOF HOSE

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CONDOR FLEXIBLE RUBBER PIPE

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R/M EXPANSION JOINTS

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"More Use per Dollar"

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*Teflon—A Dupont trademark

RM-908

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MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

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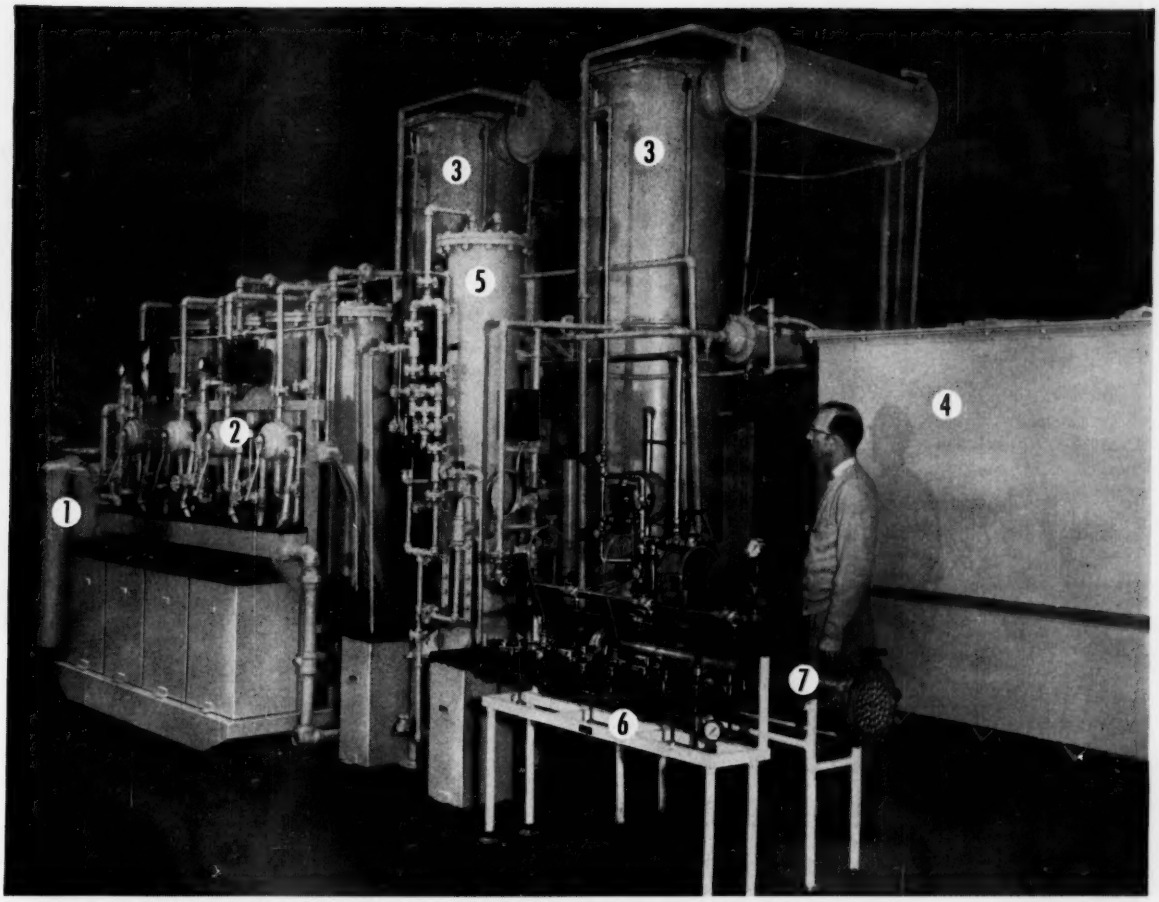

NEW BARNSTEAD WATER PURIFICATION EQUIPMENT PRODUCES 18,000,000 OHM WATER IN PRODUCTION QUANTITIES

PROBLEM: A large electronics firm needed 18,000,000 ohm* water free of bacteria, organics, silica, and submicroscopic particles. Existing purification methods could not produce it in either the purity required nor in the quantities needed. Further, the slightest amount of impurities in the firm's rinsing and washing operations would result in a high rate of rejects, raised manufacturing costs, and in some cases a permanently damaged product, noticeable when in use by the ultimate consumer.

SOLUTION: Since demineralizers would provide high ionic purity but would not solve the problem of bacteria, colloidal impurities, dissolved gases, organic matter etc., the use of distillation combined with other purification methods became necessary. Barnstead recommended the following equipment operating in series. 1. Sand and carbon filter for preliminary treatment of raw water. 2. A four-bed, extra-high capacity demineralizer for removal of most ionizable impurities. 3. Two Barnstead new high-purity Stills to remove the remaining non-ionizable, suspended, and gaseous impurities. 4. Box-type tin-lined tank for intermediate storage. 5. Mixed-bed demineralizer for removal of final traces of ionizable impurities. 6. Barnstead MF® Submicron Filter for removal of submicroscopic particles down to 0.45 micron. 7. Tin-lined heater for final heating of water to desired temperature for manufacturing operation.

RESULT: This Barnstead Pure Water Equipment, especially designed for this particular manufacturing operation, produces 18,000,000 ohm water completely free of bacteria, organics, silica, and submicroscopic particles. Thus a new manufacturing procedure becomes a reality through Barnstead Pure Water Engineering.

If you need Pure Water, in either laboratory amounts or production quantities, come to Barnstead with your problem . . . Pure Water Specialists Since 1878.

NEW PURE WATER LITERATURE

Catalog "G" describes Barnstead Water Stills in capacities of from ½ to 1000 g.ph. Catalog 127 on Barnstead Mix-Bed, Two-Bed, and Four-Bed Demineralizers. Bulletin 141 describes Barnstead MF® Submicron Filter for filtering out particles down to 0.45 micron.

*temperature corrected to 25 C.

WATER STILLS AND DEMINERALIZERS FOR EVERY PURE WATER NEED . . .

Barnstead STILL & STERILIZER CO.
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BOSTON	NEW YORK	PHILADELPHIA	CHICAGO	CLEVELAND	LOS ANGELES	SAN FRANCISCO
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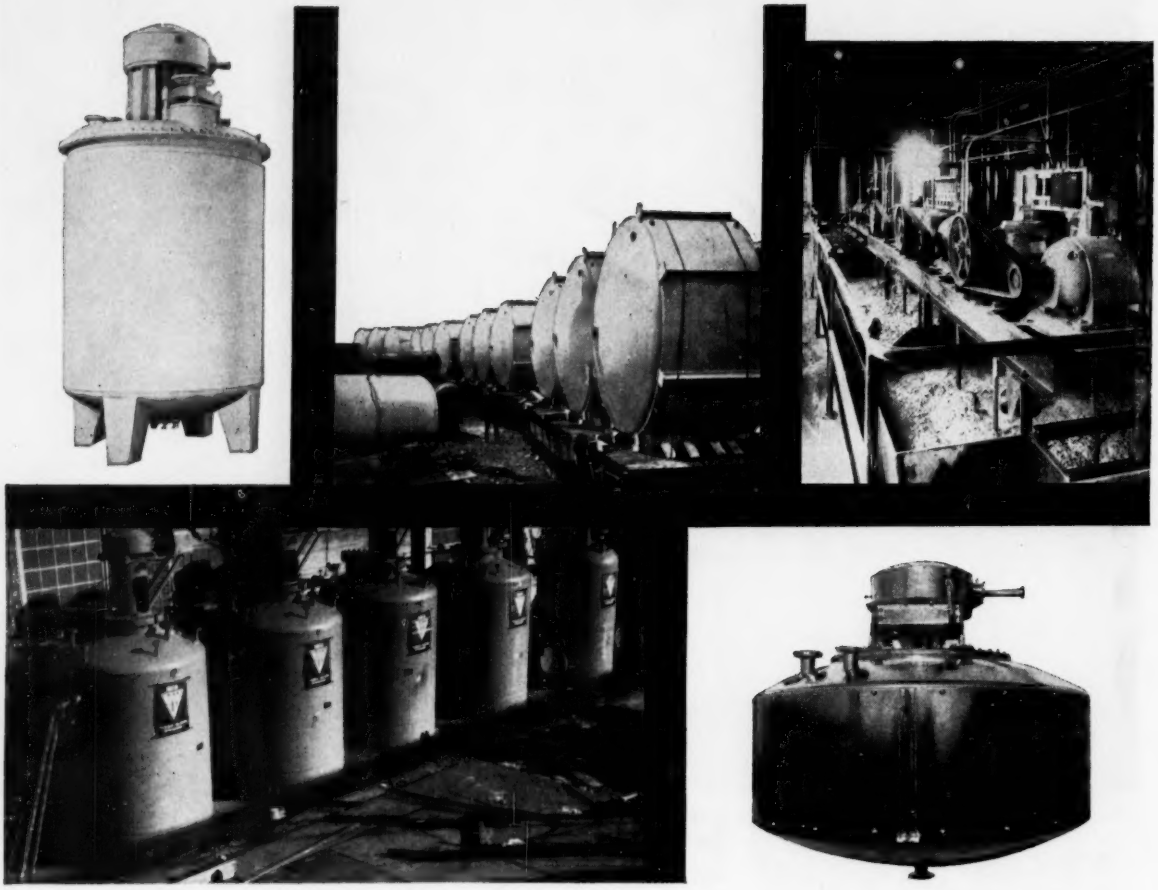
one source...one responsibility...



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General American's Turbo-Mixer Division not only supplies you with the most effective and economical mixing equipment, but with tank and supporting structures, drive and special accessories.

This "one package responsibility" saves you money, assures perfect harmony of all components in your production line, and long, trouble-free performance.

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Process Equipment Division

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GENERAL AMERICAN TRANSPORTATION CORPORATION

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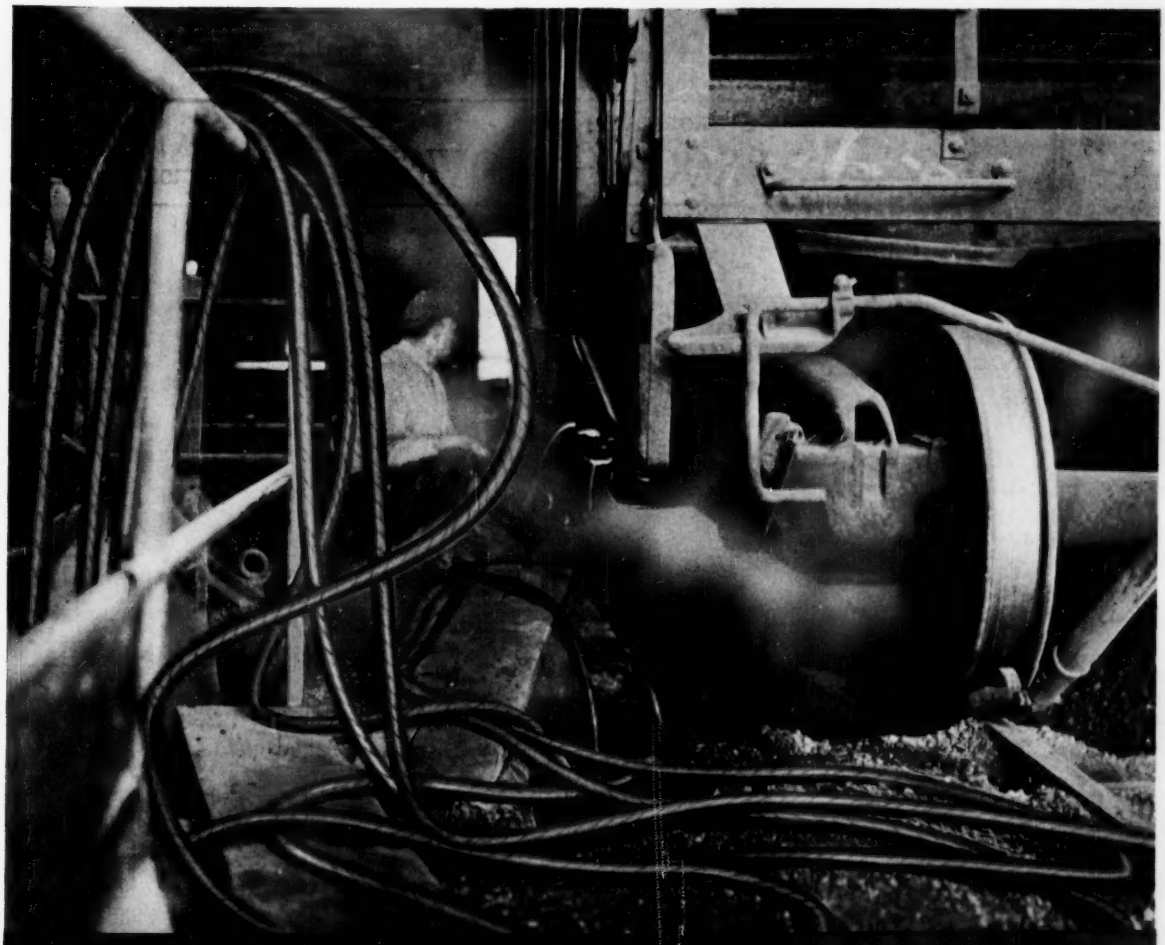


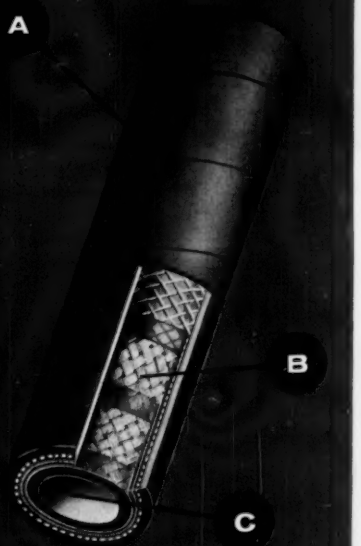
This plant turns on the steam to break loose frozen coal

The faster the coal flows the less it costs. This calls for steam at high pressure, and calls for a high pressure steam hose that's burst-protected, flexible, easy to handle. Management decided on Acme-Hamilton's wire braided steam hose because it meets all requirements and can be used for all steam applications safely and economically.

(A) Cover. Heat, abrasion, oil, sunlight and weather resistant.

(B) Carcass. 1 or 2 braids of high tensile wire. Prevents bursting, yet is very flexible.

(C) Tube. Handles saturated steam to 385°F. 200 lbs. working pressure. Won't loosen, soften or flake. Write Dept. M91.



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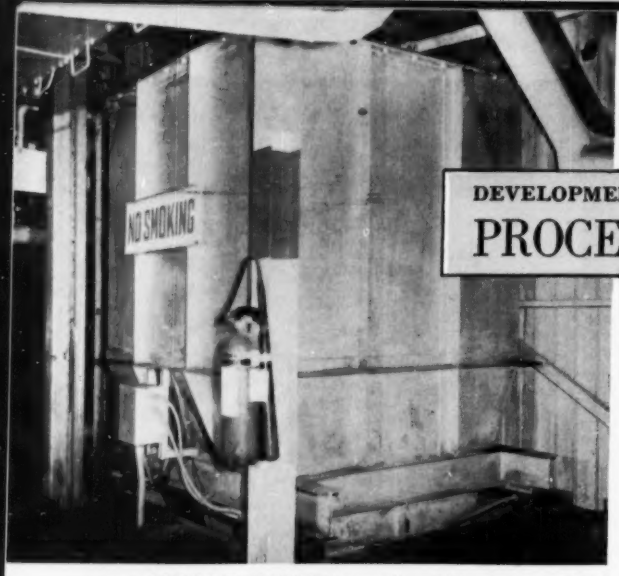
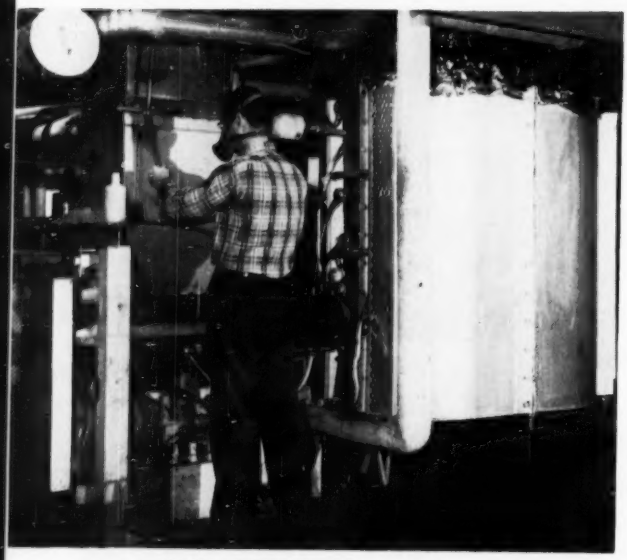
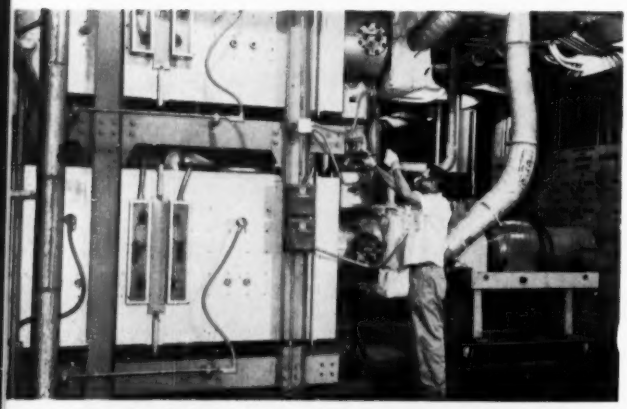


1 CHARGE HOPPER supplies UO_3 raw material to fluid bed reductors via a seal hopper.



2 FLUID BED REDUCTION: First stage begins uranium trioxide conversion to dioxide.



3 HYDROFLUORINATION: Anhydrous HF converts UO_2 to UF_4 in this screw reactor.

DEVELOPMENTS ...

PROCESS FLOWSHEET

C. S. CRONAN

Conversion of Uranium Trioxide to Uranium Hexafluoride

In Three-Step Process

Process handles variable-quality UO_3 feed, controls high reaction heats, holds to close, high temperature limits, involves handling of 1,000 F., moist HF gas.

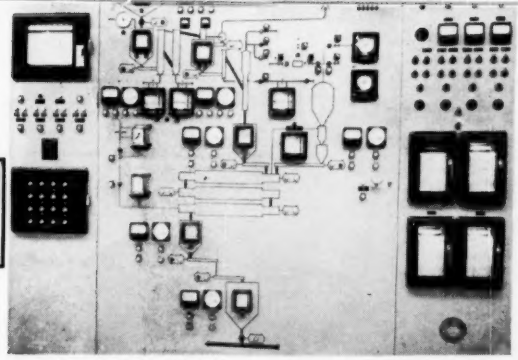
TO SATISFY demands for an uninterrupted supply of uranium hexafluoride to the U-235-producing, gas-diffusion plant at Paducah, Ky., Union Carbide Nuclear Co., Div. of Union Carbide Corp., now utilizes its own continuous processing route to UF_6 at the same location.

Process converts uranium trioxide, from solvent extraction of virgin-ore concentrates or reprocessing of spent fuels, to uranium hexafluoride. Medley of gas-solid phase reactions comprises process: H_2-reduction of UO_3 to UO_2, hydrofluorination of UO_2 to UF_4 and fluorination of UF_4 to UF_6.

▶ **Requires Close Control**—Each of these reactions is extremely exothermic, therefore, must be closely controlled. And because quality of UO_3-feed material varies widely, process must be very flexible and self-adjusting.

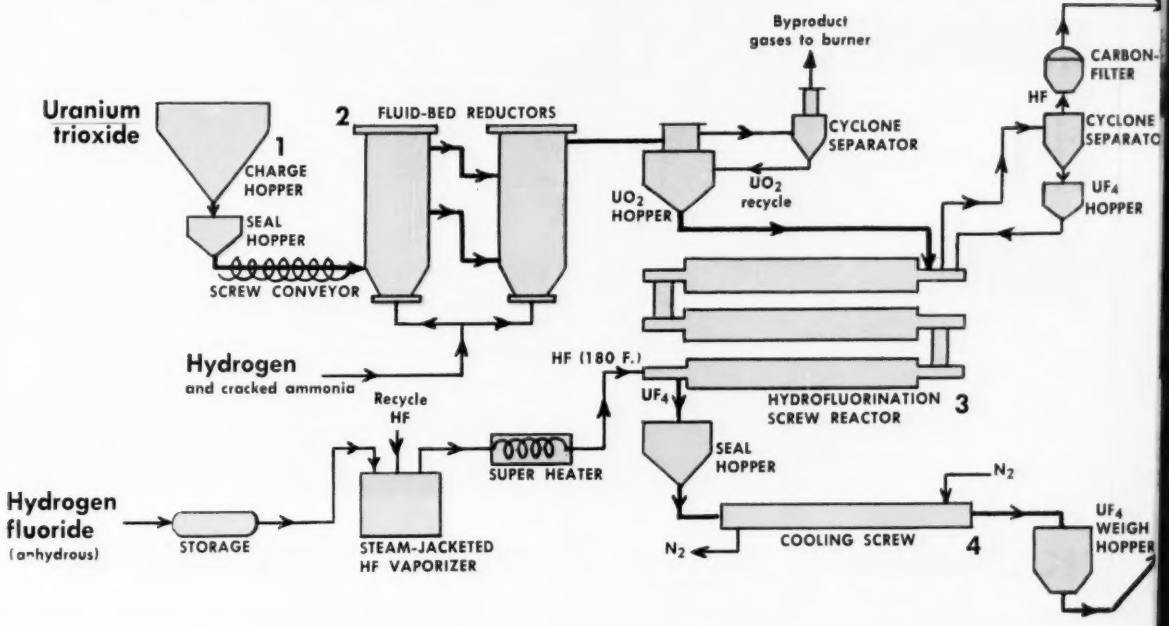
Union Carbide Nuclear meets these processing

Pictured Flowsheet



Panel controls medley of chemical reactions.

$$UO_3 + H_2 = UO_2 +$$



challenges by utilizing elaborate process control and flexible equipment such as fluid-bed reductor, screw-conveyor hydrofluorinator and flame-fluorination reactor.

Because process recycles unused reagent, utilization averages 99%. And to facilitate operational economy still further, complete process control reduces need for operator attention, automatically adjusts process conditions to suit variable feed material.

▶**Process Flow**—Two-stage fluidized-bed reductor first converts uranium trioxide feed to uranium dioxide.

Hopper with 5-ton capacity stores UO_3, gravity-feeds raw materials, as required, to a seal hopper, then to a screw conveyor which feeds the first reductor stage.

Fluid-bed reductors are twin units, 14-in. dia., and 5-ft. high. Hydrogen reducing gas and cracked ammonia fluidizing agent, feed into reductors at 10-15 psi. through their porous, diffusion-plate bases.

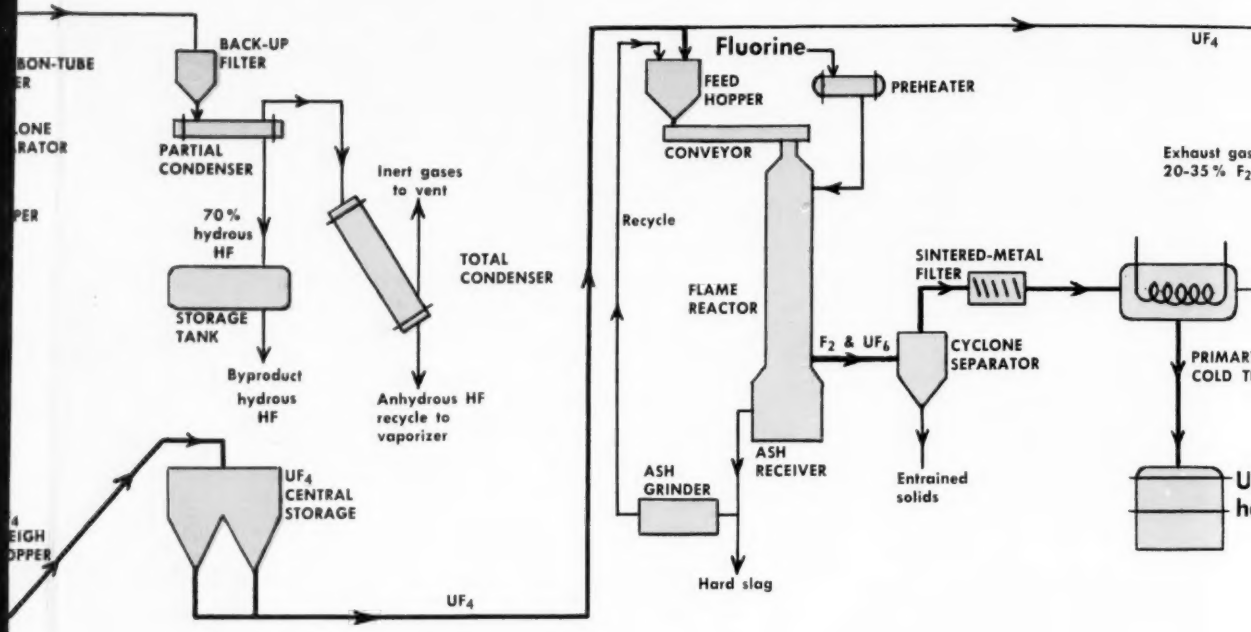
Uranium trioxide reduction proceeds to 33-50% completion in the first stage. Mixture of UO_3 and UO_2 overflows through downcomers to the second stage. Gas-UO_2 discharge from the second reductor flows to the UO_2 hopper.

Gas-solid mixture consists of water vapor, hydrogen, nitrogen, traces of hydrogen sulfide and entrained UO_2. Cyclone separator removes entrained UO_2, returns it to the hopper. Byproduct gases are burned and freed of entrained solids before being vented to the atmosphere.

Hopper supplies UO_2 to hydrofluorination reactor, where counterflowing anhydrous HF converts it to UF_4. Reactor consists of three, 16-in. dia., 20-ft.-long, Inconel tubes, arranged horizontally, one on top of another and equipped with motor-driven ribbon screws.

Air cooling at individual zones, removes heat of extremely exothermic hydrofluorination from poor-thermal-conductor UF_4-UO_2 mixture. Zone cooling prevents sintering of powders, and maintains required temperature profile along the tube

+ H_2O $UO_2 + 4HF = UF_4 + 2H_2O$



length. Initial UO_2 hydrofluorination takes place at 550 F., but to assure reaction completion, temperature increases along tube length to 1,000 F. at the UF_4 exit.

▶**Hydrogen Fluoride Supply**—Liquid anhydrous HF is supplied by tank car. Steam-jacketed vessel, near hydrofluorinator, vaporizes HF; steam-heated exchanger superheats vapor to 180 F. Superheated vapor is first reduced to 5-psi., then fed to hydrofluorinator.

Excess HF, required to assure complete UO_2 hydrofluorination, flows through tube reactor, picks up reaction-product steam and UO_2-UF_4 dust. Cyclone separator removes entrained UO_2-UF_4, which recycles to the reactor.

Steam-bearing HF flows through a steam-jacketed carbon filter and back-up filter that remove dust traces, thence to a partial condenser. Here, 70% byproduct acid condenses out; anhydrous HF and inert gases flow on to the total condenser where they are chilled to −40 F. Anhydrous HF condenses, recycles to vaporizer.

▶**Cooling UF_4**—Hydrofluorination product, UF_4, cools from 1,000 F. to 300 F. from contact with refrigerated nitrogen in a cooling screw, then goes to a central storage tank.

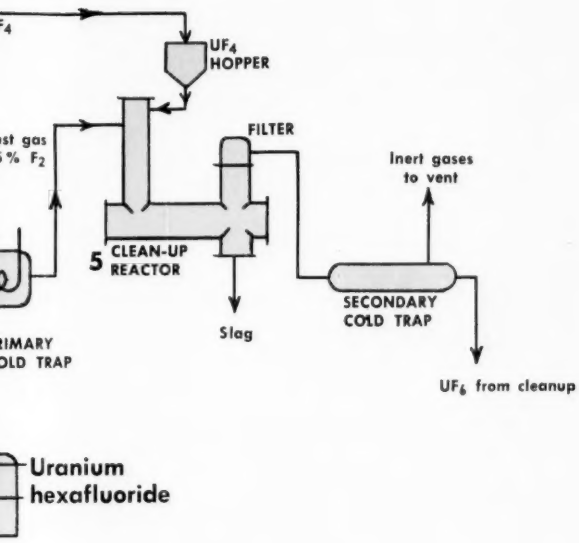
Next, a flame reactor converts UF_4 to UF_6 by fluorine combustion. Flame reactor is a 12-ft.-long, 8-in.-dia., Monel pipe, equipped with ½-in.-dia., Monel water-cooled coils.

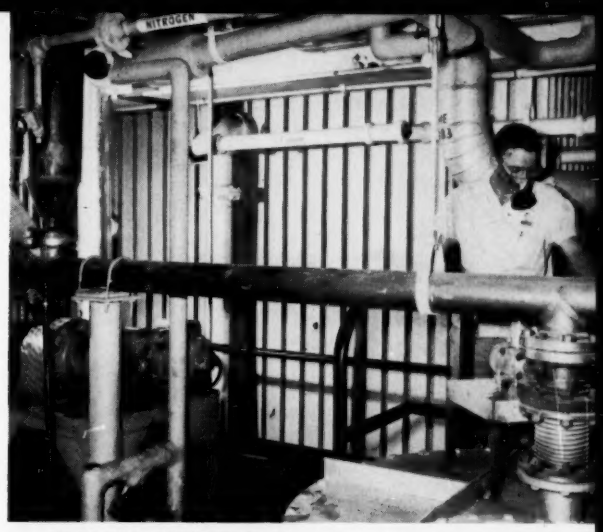
Fluorine, preheated to 600-700 F., feeds flames reactor via four jets. Spined-shaft stirrer, driven at 1,800 rpm., intimately mixes gas and solids. Water, forced through cooling coils, keeps reactor wall temperature within 600-1,000 F. range.

▶**Recycling Slag**—Unfluorinated ash, 1-2% of UF_4 feed, drops into ash receiver at reactor base, is conveyed to crusher and screen assembly. Hard slag, containing 15% foreign metal, is rejected by screen, cycles to nitric-acid dissolution unit for uranium recovery. Crushed and screened slag recycles to flame reactor feed.

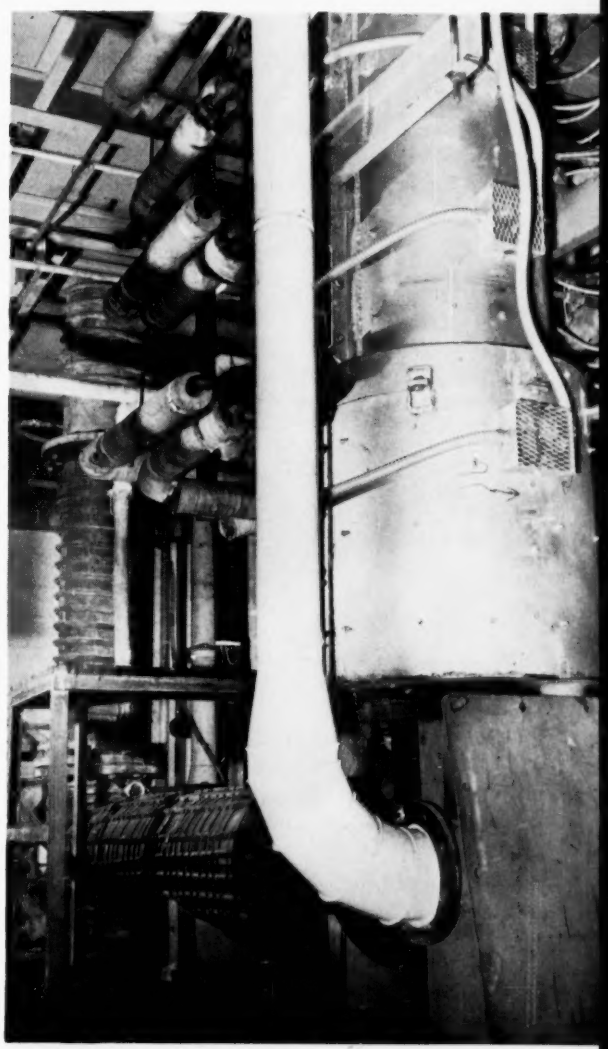
Gas, containing 75% UF_6, flows through water-jacketed pipe and two water-cooled cyclone sepa-

$$UF_4 + F_2 = UF_6$$





COOLING SCREW: Refrigerated nitrogen cools uranium tetrafluoride from 1,000 to 300 F.



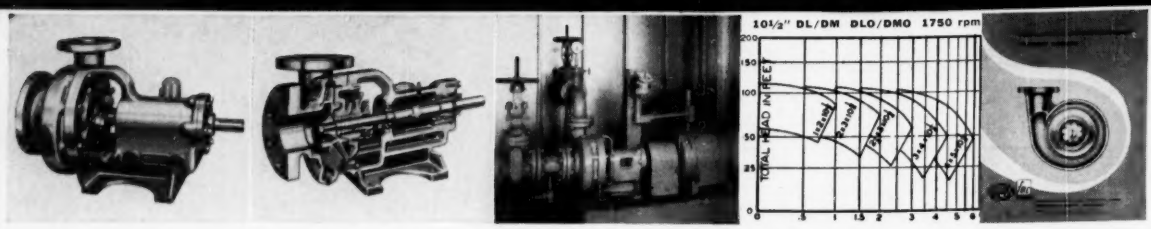
CLEAN-UP REACTOR burns fresh UF_4 with exhaust fluorine from cold trap.

rators, which remove entrained solids. Sintered-metal filter removes solid traces.

Flame-reactor gas, free of solids, flows into primary cold traps, 54-in.-dia., 15-ft.-long condenser shells containing 48, cupronickel, ½-in. dia. finned tubes. Traps are insulated with plastic blocks.

▶ **Freezing Out Product**—Ethylene glycol, chilled by an external ammonia cycle to 0-15 F., solidifies UF_6. In second phase of two-cycle process, relatively warm glycol displaces cold glycol from tubes, melts solidified UF_6. Product drains into a 10-ton withdrawal cylinder.

Primary-cold-trap exhaust gas flows to the second flame reactor where its 20-35% F_2 content converts fresh UF_4 to UF_6 gas. Slag-gas mixture flows down into horizontal screw at reactor base, which pulverizes slag and cools gas. Secondary cold trap, similar to primary trap, discharges liquid UF_6 to a cylinder. Maximum fluorine utilization is thus achieved, while additional UF_6 product is produced.



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OFFER optimum performance range, you benefit from the economical performance only the exact pump for the job can give you. The Peerless process pump line of over 78 models, sizes and frames, plus thousands of combinations, assures you of pinpoint pump selection that effects direct savings in cost.

EMBODY benefits of research in all areas of design, construction, and application. Typical of the many considerations in the design and manufacture of a Peerless pump is the ascertaining of effects of radial loads. **An interesting 8 page booklet discussing this phase of pump design is available to you upon request.**

Engineers and Pump buyers say:

"PEERLESS PUMPS IT BEST!"

...buy and apply PEERLESS PUMPS

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paper pulp to pipe . . . through HEAT

Hess-Snyder's new Despatch Drying Oven bakes paper pulp pipes to astounding hardness

Need an underground pipe? Hess-Snyder Company, Massillon, Ohio, will make it for you . . . out of cellulose fibre and pitch.

It's called Bituminous Fibre Pipe . . . and it's amazingly hard. It's root proof, is only 1/6 the weight of cast iron, is easy to install and can be sawed to any length right on the job.

What's the secret? The answer is cellulose wood fibre formed into a tube in a huge new Despatch batch type convection oven. Impregnation with coal tar pitch completes the operation.

When the wet tubes come off the rolling mill, they are loaded onto carts and wheeled into the oven, where they dry from 18 to 36 hours. The oven must dry the tubes slowly and *exactly* or water is trapped inside the hard crust where it later causes "splits." The new Despatch oven solves this problem.

Mr. Norman J. Gaynor, Vice President of Hess-Snyder says: "We chose the competitively-priced Despatch Oven because of its proven ability to adhere to close heat tolerances. The oven also operates efficiently under intermittent interruption, that is, changing the size of tube to be dried from day to day. Then, too, we were given tremendous installation assistance by Despatch, who assigned an engineer to work with us for 3 full weeks." Here is another example of Despatch's leadership in the heat processing industry. For *any* heat problem, large or small, you can trust Despatch's unmatched experience—50 years and more than 50,000 installations.

For information, write or call:

DESPATCH OVEN COMPANY

619 S.E. 8th St., Minneapolis 14, Minn., Dept. 502I

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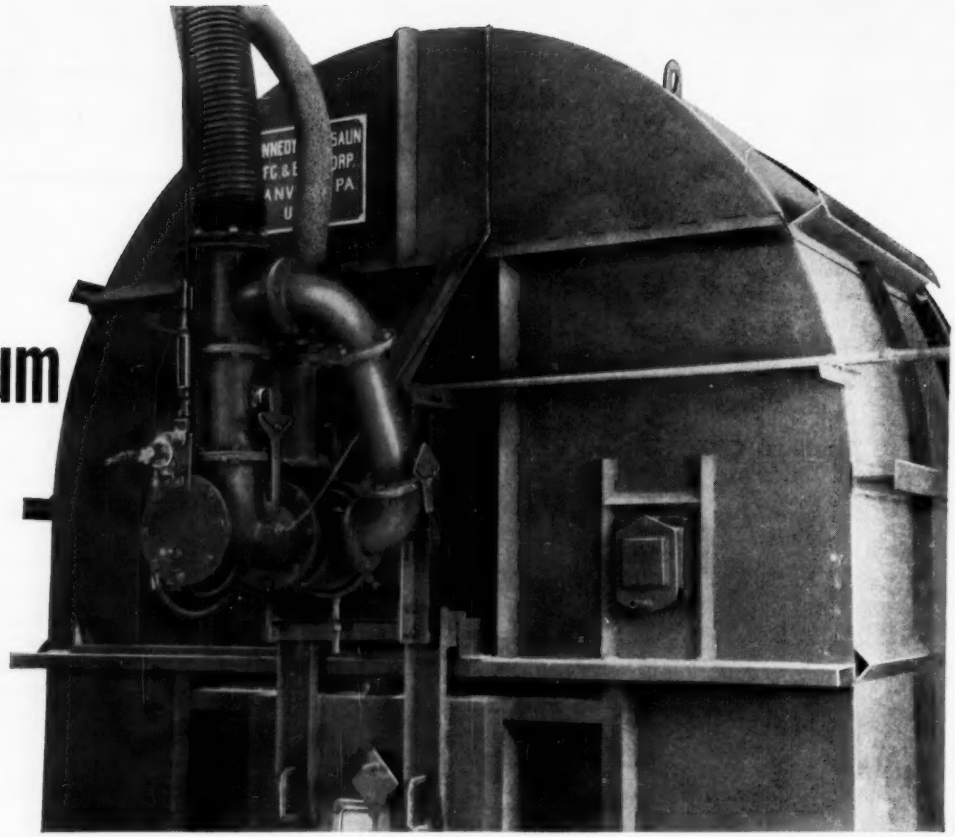

KENNEDY KILN FIRING SYSTEMS

When seeking economies in rotary kiln operation, either through decreased fuel consumption or increased kiln capacity, look first to your firing system. These economies are dependent primarily upon a perfectly balanced and controlled fuel and primary air supply. This is inherent in all KENNEDY Kiln Firing Systems.

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A KENNEDY Kiln Firing System answers the need for "Maximum Firepower."

FOR PULVERIZED COAL—KENNEDY's Air Swept Grinding Mill, proven in many successful steam power plants, cement plants, and lime plants, supplies properly-sized coal particles to the burner, combined with exactly the right quantity of primary combustion air. Low maintenance, reliability, automatic feed control, quick response to changing loads and replacement of grinding media without shutdown, make this the ideal system for kiln or boiler firing service.

FOR GAS—The KENNEDY Gas Firing System is the only system which produces a luminous flame, of adjustable length, assuring maximum radiation of heat with maximum efficiency over a wide range of capacity.

FOR OIL—Fuel Oils of any grade yield maximum heat per fuel dollar when burned in a KENNEDY Kiln Firing System.

Take advantage of the added economy and performance which is characteristic of KENNEDY Kiln Firing Systems. Consult KENNEDY's engineers.

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Smoothing out Level Measurement Problems with the Robertshaw Level-Tel

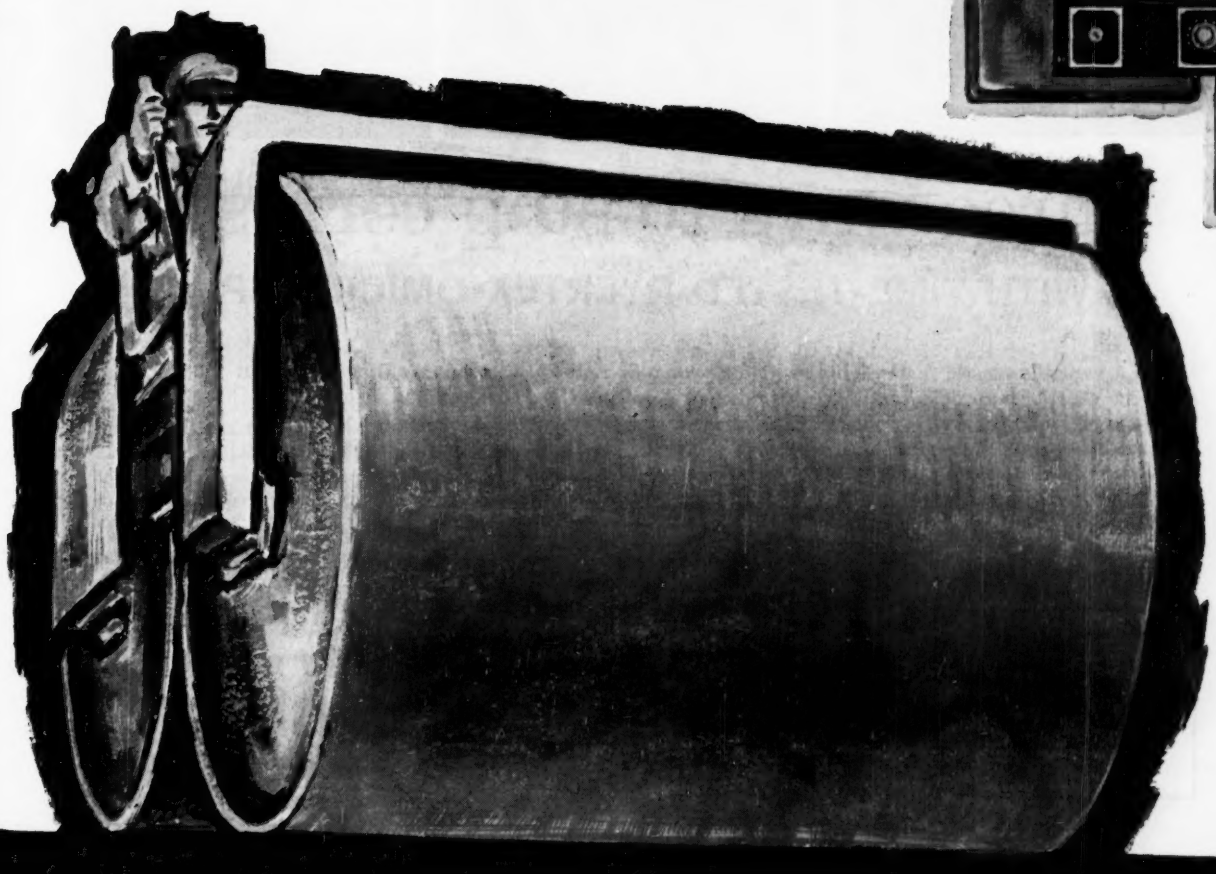
PROBLEM: How to measure bin level changes *accurately* in hot, hard-to-handle, extremely abrasive materials.

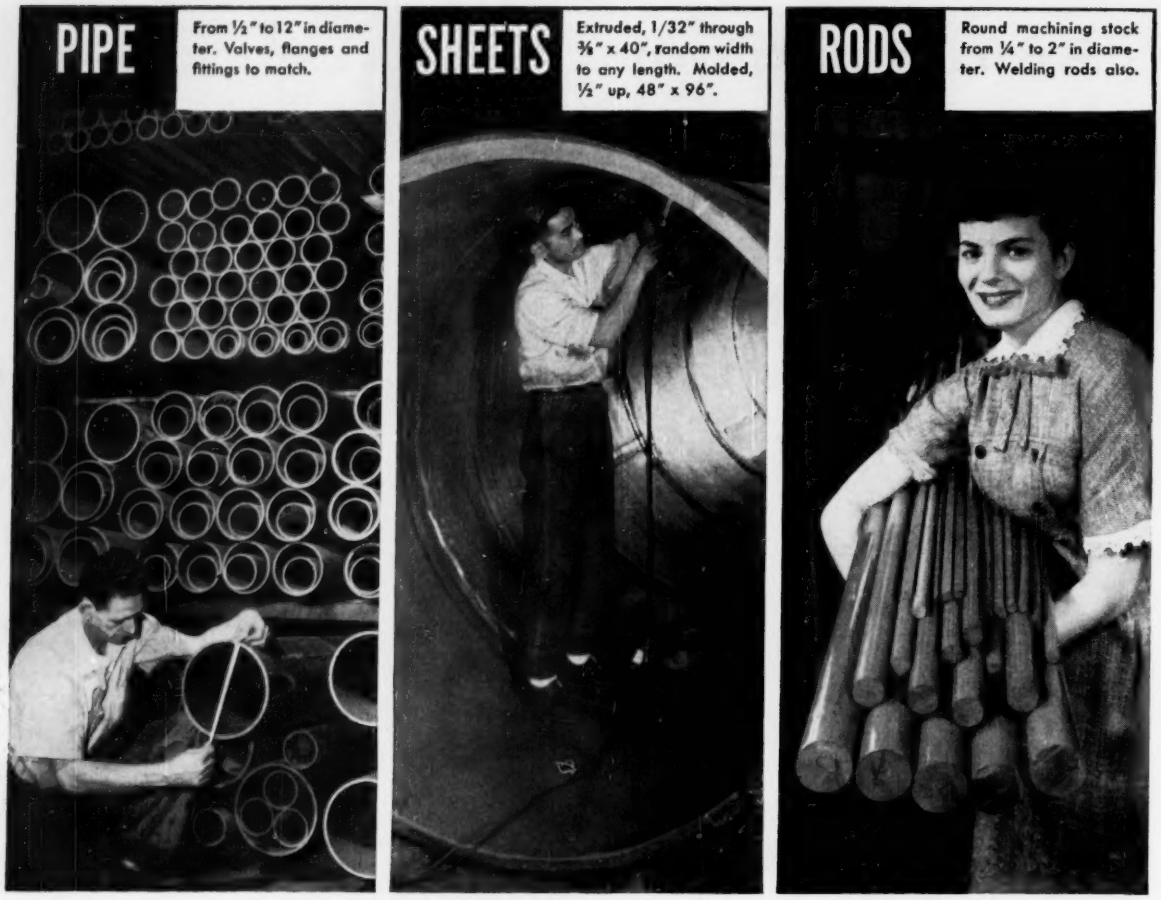
SOLUTION: The Robertshaw Level-Tel continuous level indicator.

EXAMPLE: The four hot gravel bins at the Valley Asphalt Plant, City of Los Angeles, are relatively inaccessible, too hot to touch and contain no open ports. Reaching deep into each of the bins, a probe specifically designed for rugged duty continuously detects the changing gravel level and, by means of a simple capacitance bridge, relays the information to the plant control room. Previously, the operator had no way of knowing accurately the gravel level in each bin prior to mixing with liquid asphalt. Blacktop from the plant is used for road repair throughout California's burgeoning San Fernando Valley.
Installed two years ago, the Robertshaw continuous level measuring system has required no maintenance, while performing with extreme accuracy. According to Valley Plant engineers, the Level-Tel system has speeded up plant operation, reduced bin overflow and enabled them to determine easily the best time to change formulations.

SUGGESTION: The Valley Asphalt Plant operation is just one of many possible Level-Tel applications. If you are engaged in processing, manufacturing, refining or mining, there's a Robertshaw quantitative measurement and control system to fit your specific requirements. Write for Bulletin RF-583-5.

Aeronautical & Instrument Division, Robertshaw-Fulton Controls Company, Santa Ana Freeway at Euclid Avenue, Anaheim, California.




PIPE
From ½" to 12" in diameter. Valves, flanges and fittings to match.
SHEETS
Extruded, 1/32" through ⅜" x 40", random width to any length. Molded, ½" up, 48" x 96".
RODS
Round machining stock from ¼" to 2" in diameter. Welding rods also.

Three ways to stop corrosion

WITH TIME-TESTED RYERTEX-OMICRON PVC

Here's a versatile plastic that's lightweight (only one-sixth the weight of steel) . . . yet is tough and durable. Time-tested by 20 years of varied application, it resists weathering, rotting and aging indefinitely. It's Ryertex®-Omicron PVC—and available only from Ryerson. This nonmagnetic, nonsparking PVC will not support combustion . . . and in many applications is used successfully at operating temperatures up to 200°F.

LICKS 281 CORROSIVES

Lab tests have proved that this remarkable plastic resists 281 corrosive solutions and gases—including acids, alkalies, waste products, etc.

This unique PVC forms easily, cuts with a handsaw, welds readily with hot-air equipment, machines at high speeds on standard equipment. Pipe can be joined by brushing on solvent and applying fitting—and the joint is as strong as the pipe itself.

Find out whether Ryertex-Omicron PVC answers your corrosion problems. Write your nearby Ryerson plant for Bulletin 80-3.

Typical applications

Tanks and tank linings, troughs, pipelines for liquids or gases, fumes systems, blowers, roof ventilator housings, chutes, filter plates, splash covers, neutralizing acid equipment, settling and scrubbing towers—and many others.

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March 23, 1959 Chemical Engineering

Alpha Plastics

How and When to Use . . .

Plastic Pipe

Down-to-earth engineering information—to help you weigh the advantages of the latest in chemical process piping.

G. SORELL, The M. W. Kellogg Co., New York, N. Y.

EXPLOSIVE is a good word to use in describing the growing use of plastic pipe in this country.

Sales of plastic pipe have increased one-hundred fold from an annual $500,000 in 1948 to an estimated $50,000,000 for 1958. Informed guesses predict sales will reach $100,000,000 by 1961 and surpass the quarter-billion dollar mark prior to 1975.

The reason for this growth is not hard to find. Plastic pipe is finding ever-increasing applications as an effective alternate to metal pipe. These applications cover a broad range, from large overland pipelines to backyard lawn sprinkler systems.

But of special significance to chemical engineers is its proved effectiveness for conveying, in addition to water, highly corrosive gases and liquids—substances previously calling for expensive alloys or nonmetallics.

Now that this field has come of age, it's important that we develop and maintain a thorough, up-to-date working knowledge of plastic pipe technology. We hope this Report will be of some aid toward this end.

Advantages and Disadvantages

The general advantages of plastic over metal pipe are many: light weight, ease and economy of installation, low friction factor and fouling tendency, good

10 Advantages of Plastic Pipe

- Light weight
- Low relative cost
- Good chemical resistance
- Low friction factor
- Low fouling tendency
- Low electrical conductivity
- Low thermal conductivity
- Savings on shipping costs
- Easy to install and repair
- Savings on external protection

But Know the Disadvantages

- Poor resistance to temperature
- Poor resistance to pressure (thermoplastics)
- Poor mechanical strength (thermoplastics)
- Poor dimensional stability
- High expansion rates
- Poor resistance to physical abuse and fire
- Inadequate standards

Which Plastic Is Best?

Here are the plastics commercially used in pipe—thermoplastics, thermosets, reinforced, rigid, flexible. Some are better for high temperatures, others for corrosive service. Get to know what each can and cannot do.

chemical resistance, low electrical and thermal conductivity (self-insulating), low shipping costs, savings on external protection (painting, wrapping). Moreover, plastic pipe is relatively inexpensive compared with stainless steels and other corrosion resistant alloys.

But there are disadvantages: lack of resistance to elevated temperatures and pressures, poor mechanical strength and dimensional stability, high coefficient of thermal expansion, poor resistance to physical abuse.

In our discussion—which will cover plastic varieties, mechanical properties, costs, fittings, installation methods—special emphasis will be given to shortcomings. This is not intended to create prejudice against plastic piping, but to restore proper perspective to a field badly distorted by some over-enthusiastic and frequently irresponsible advertising claims and trade literature.

Of course this situation is rapidly improving as more and more reputable companies get into the field. Development of improved products, standards and specifications, and more reliable design data will insure plastic pipe's place in the chemical and petroleum industries.

Plastic materials are classified into two basic groups—thermoplastic and thermosetting resins.

Thermoplastic materials can be softened and reshaped repeatedly by applied heat. Thermosetting resins set or harden into permanent shapes after a single heating. Thereafter their shapes cannot be appreciably changed by heating.

Thermoplastics are generally lower in strength and have inferior resistance to weakening and deterioration by heat than thermosets; but thermoplastics are easier to fabricate into finished parts.

Thermosets and Thermoplastics

Thermoplastic pipe accounts for the lion's share of all plastic pipe manufactured, leaving only an estimated maximum of 5% of the market to thermosets.

Notwithstanding this limited over-all use, thermosetting piping is of special interest because of its comparatively rapid gain in the chemical process industries. Here, the inherently good properties of reinforcing materials have been used to great advantage. Pipe is available capable of handling severely corrosive chemicals at pressures and temperatures far beyond the service limits of thermoplastic pipe.

Practically all thermoplastic pipe is produced by the extrusion process. Such pipe ranges from flexible to rigid, depending on the type of resin and amount of fillers or plasticizers.

Thermosetting pipe is always rigid and commercially produced by a number of manufacturing processes including molding and casting, both static and centrifugal. A specialized process is used to produce laminated plastic pipe reinforced with mats, rovings, continuous filaments, or woven fabrics of glass or synthetic fibers.

Polyethylene: Low Cost

Low-density (Type I) polyethylene is the cheapest, lightest and most common type of plastic pipe, comprising at least $\frac{3}{4}$ of the dollar market.

Polyethylene pipe, commercially available in coils and straight lengths since 1948, is flexible and easily assembled with insert fittings and hose clamps. It has good chemical resistance but is subject to fairly rapid deterioration in outdoor exposures unless properly compounded with ultraviolet light screeners such as carbon black.

Perhaps the single most outstanding characteristic is excellent impact resistance down to sub-zero temperatures. This property, combined with a high degree of flexibility, makes it possible for polyethylene water lines to freeze without rupturing.

Polyethylene pipe is manufactured in two quality grades designated "virgin" and "reprocessed." Although the lower priced reprocessed grade may be satisfactory for many industrial applications, its use is not advocated for critical services requiring optimum mechanical and chemical properties. Only pipe extruded from virgin material is eligible to receive the NSF Seal of Approval for potable water service.

Major disadvantages of conventional polyethylene are softness (easily damaged by cutting), low softening temperature, lack of strength and stiffness, and consequently low working pressures and operating temperatures. Also, it is flammable, subject to environmental stress cracking, and readily softened and swelled by hydrocarbons.

New Resistant Type

The poor resistance of low-density polyethylene against heat and mechanical failure can be improved by irradiation which produces cross-linking. But a commercially more important method for achieving better properties is through recent low-pressure manufacturing processes which produce denser materials.

Two commercially important

low-pressure (under 500 psi.) ethylene polymerization processes were developed by Karl Ziegler of Germany and the Phillips Chemical Co. in the U. S. More recently, the Allied Chemical Corp. has entered the field with their own low-pressure process, producing a high-density and ultra-high molecular weight product.

Proper formulations of the high-density (Type III) polyethylenes have greater strength, rigidity, hardness and heat resistance than low-density (Type I) and medium density (Type II) resins.* As a result of these improved properties, pipe extruded from the high-density material is suitable for somewhat more severe industrial applications than can be handled by Types I and II.

A new development showing promise for pipe application: carbon-black-loaded (up to 50%), chemically cross-linked (with organic peroxides) polyethylene, already in commercial use for wire and cable covering. This modification confers higher strength and thermal stability to conventional polyethylene resins. It's also claimed to produce almost complete immunity to weathering and environmental stress cracking.[1]

ABS Polymers: Big Seller

High-impact-resistant resin polymers of acrylonitrile, butadiene and styrene—correctly designated as ABS polymers—are popularly called by a variety of names such as styrene copolymers, modified polystyrene, or simply resin-rubber.

ABS pipe is light, chemically resistant and retains excellent impact strength even at sub-zero temperatures. Next to polyethylene, it is the largest seller, accounting for about one-sixth of the total plastic pipe market. The vast majority of the 40 odd million ft. of rigid and semi-rigid ABS pipe installed since its introduction in 1947 is of the Type I resin.* (Marbon Chemical's Cycolac L, Naugatuck Chemical's Kralastic B).

Recently, an improved formulation of ABS resin known as Type II has been introduced on the market by Marbon and Naugatuck.[2, 3]

Pipe extruded from these stronger resins (Cycolac C, Kralastic HTHT) is claimed to be suitable for operation at higher pressures and temperatures than any of the common thermoplastic pipe materials. Therefore, Type II ABS pipe may extensively supplant Type I pipe, except in sub-zero temperature services where the higher impact resistance of the Type I grade makes it superior.

Several service failures have occurred with Type II ABS pipe, but the cause has been attributed to poor extrusion techniques rather than to any inherent shortcomings of the resin. Once these fabrication difficulties are overcome, Type II ABS pipe may prove to be stiff competition to PVC pipe for chemical industry applications.

Rigid PVC: High Strength

Rigid or unplasticized polyvinyl chloride (PVC) has been used widely in Germany for nearly 25 years, but was not introduced in this country until about 10 years ago. Since then, it has risen to the number three spot in the plastic pipe market (approximately 10% of total).

PVC has high strength, good dimensional stability, excellent chemical resistance and does not support combustion. It is however, considerably heavier than the other common thermoplastic pipe.

PVC is manufactured in two commercial grades, designated as Type I and Type II. Type I or Normal Impact PVC is the more widely used grade; Type II or High Impact PVC is much more resistant to failure by mechanical shock, but the modified resins in Type II produce a material less resistant to temperature and chemicals.

New Type Available

Recently, a new version of Type I PVC has been introduced in this country based on Montecatini's Vipla resin. Ryertex-Omicron pipe (Joseph T. Ryerson & Sons), extruded from this resin in the U. S., is claimed to possess higher impact strength and greater resistance to corrosion and heat than other comparable products.

In addition to its use in extruded rigid pipe, PVC resin is also found in a variety of special pipe and tubular products.

The oldest of these applications is for flexible pressure tubing, such as Tygon (U. S. Stoneware Co.).

For services requiring greater bursting strength, vinyl chloride tubing can be furnished with an external reinforcing braid of plastic or stainless steel. A spectacular application of metal-supported PVC tubing (rated at 2,000 psi. design pressure) is currently undergoing service tests as a 900 ft. crude oil line submerged in 35 ft. of sea water.[4]

Another novel application of Type I PVC is in the form of a rigid, mechanically bonded inner liner for steel pipe (J & L's Jal-Jacket, Swepco Tube's Swepcore). The metal backing permits higher working temperatures (up to 190 F.) and working pressures (up to 1,000 psi.) than can be sustained by unsheathed PVC pipe.

Omega is another new tubular product (Omega Co.) using a rigid PVC liner. In place of a steel shell, the outer reinforcing jacket consists of epoxy-impregnated helically interwoven glass fiber filaments. PVC resin is also employed in the form of a chemically-bonded, integrally-cured liner for some brands of glass-reinforced polyester and epoxy pipe.

Butyrate: Moderate Resistance

Cellulose acetate butyrate (or simple butyrate) known under the familiar Tenite Butyrate trade name (Eastman Kodak), represents an estimated 2% of the plastic pipe market.

Depending on resin formulation, butyrate pipe can be produced in various degrees of stiffness, ranging from flexible to rigid. Optical characteristics can also be controlled to produce a wholly transparent or opaque material.

CAB has fairly low mechanical strength and only moderate resistance to temperature, chemicals and weathering. Moreover, it is brittle at low temperatures and, similar to polyethylene and ABS resins, supports combustion.

Even with these detriments, industrial installations of butyrate pipe have generally given good performance and service life. Butyrate pipe has been used extensively in petroleum production, principally for carrying salt water, crude oil and natural gas. One of its most attractive features for petroleum

* Types I, II and III polyethylenes are defined with respect to the following specific gravity ranges in ASTM D-1248-58T: Low density (0.910-0.925), medium density (0.926-0.940), high density (0.941-0.965). In popular terminology, low density frequently includes both Types I and II.

service is its resistance to paraffin build-up.

Butyrate pipe is also used extensively by the gas distribution industry, but principally as inserts for new or existing steel lines.[23, 24]

Saran Pipe Waning

Vinylidene chloride, popularly known as saran, was the first important industrial application of plastic as a pipe material in the U. S., dating back over 15 years. Nowadays saran piping has largely been replaced by the more common thermoplastic pipe materials previously discussed which are not only cheaper but in many respects superior. Disadvantages of saran pipe are high weight, tendency to cold flow, and brittleness, especially at low temperatures.

Notwithstanding saran's waning popularity as self-supporting plastic pipe, it continues to find extensive application as a mechanically bonded internal lining for steel pipe. Saran-lined pipe, combining the good corrosion resistance of saran with the strength and stability of steel, has enjoyed outstanding success in the chemical processing field for more than 10 years.

High-Impact Styrene

High-impact styrene, not to be confused with ABS polymers, is used in the manufacture of non-pressure drain and sewer pipe. Produced in both standard and perforated varieties, these inexpensive conduits find application for the type of installations long dominated by clay tile and bituminized fiber (Orangeburg) pipe.

Fluorocarbons, Nylons

The most interesting of the more exotic thermoplastics are the fluorocarbons which have received widespread publicity ever since Kel-F (polychlorotrifluoroethylene or PCTFE) and Teflon (polytetrafluoroethylene or PTFE) were commercially developed several years ago.

Although fluorocarbons are fairly weak, these resins justly deserve the reputation as "super-plastics." They have phenomenal chemical resistance and thermal stability over an extreme range of working temperatures (−200 to +500F).

Fluorocarbon resins are extremely expensive. This has limited their field of application to a handful of specialty installations where a premium is put on outstanding serviceability regardless of first cost.

The only commercially significant use of fluorocarbons in piping is as Teflon-lined steel pipe and fittings widely publicized in recent trade journals.*

Teflon is also available in the form of self-supporting laminated pressure pipe (Resistoflex's Fluoroflex-T Type FLT), metal-braided and rubber-sheathed pressure hose and ordinary flexible tubing.

Both Teflon and Kel-F are fabricated into a variety of cementable glass-mat-reinforced sheets. Though intended primarily for lining equipment such as tanks, chutes and ductwork, these fluorocarbon laminates also show potential promise for corrosion-proofing large diameter pressure piping.

Unlike PCTFE resins, Teflon can be extruded only with great difficulty because it gels rather than melts. This shortcoming of PTFE resin is being overcome by polymerizing it with hexafluoropropylene. The resulting copolymer (FEP) Teflon 100-X, has equivalent properties to PTFE (except for lower temperature resistance) but is readily molded or extruded on standard plastic forming equipment.[6]

Polyamide resins (nylon) are extruded into pipe and flexible tubing but are not used to any appreciable extent by the U. S. chemical industry. Although nylon is strong, tough and quite heat resistant, it has poor resistance to strong acids, and is generally too expensive to compete with the more common types of plastics. More widespread use may be anticipated with a new improved formulation (nylon 6) which will soon be available in the form of pipe and fittings.[6]

Acrylic resins (Lucite, Plexiglas) are a family of materials rarely used as piping. They are quite brittle and except for transparency have little to recommend them for pressure piping in chemical service. Acrylic tubing is used to a limited extent in the food and drug industries where its glass-like clearness is useful in providing a quick visual check on product purity.

* Currently there are four U. S. companies manufacturing Teflon-lined pipe: John L. Dore Co., Ethylene Chemical Corp., Haveg Corp. and Resistoflex Corp.

Some Promising Newcomers

Polypropylene is a newly developed thermoplastic which shows definite promise for potential application in chemical piping.[7, 8, 9] It is stronger and more heat resistant than high-density polyethylene and has equally good chemical resistance. To the best knowledge of the writer it is not as yet commercially extruded into pipe, but molded Profax (Hercules Powder) valves and insert fittings are available on the market.

Chlorinated polyether (Penton) is a newcomer in the plastics field. It may become an important material in corrosion resistant construction, notwithstanding its present high resin cost of $6/lb.[10] This polymer, made by Hercules, combines excellent heat resistance (220 F. and above), dimensional stability, and chemical inertness approaching that of the fluorocarbon resins.

Limited sizes of Penton piping are now commercially available from the Polymer Corp. of Pennsylvania (Polypenco K-51 Penton pipe). For more details on Penton see Corrosion Forum, p. 192, this issue.

Two new families of thermoplastics which show potential promise for chemical service piping are the aromatic polycarbonate resins (G. E.'s Lexan) and the linear acetals (Du Pont's Delrin), both of which will be commercially available in 1959.[11, 12]

Lexan is strong, tough, chemically resistant, and exhibits good dimensional stability even in hot oil. Its Deflection Temperature (264 psi.) is close to 300 F., indicating greater heat resistance than any of the thermoplastics except fluorocarbons.

Delrin has slightly greater strength but lower resistance to impact and heat than Lexan. Delrin's single most outstanding characteristic is claimed to be the ability to retain its fine mechanical properties during extended time under stress or during exposure to most solvents. Delrin's excellent dimensional stability, fatigue life and recovery from deformation under a wide range of conditions offer a desirable combination of properties for piping applications.

Thermosets Are Heat Resistant

Thermosetting phenolic asbestos pipe manufactured under the Haveg

trade name (Haveg 31, 41) has been available commercially for nearly 20 years and has enjoyed outstanding success in severe chemical service applications.

It is nonflammable, possesses excellent chemical resistance, has good dimensional stability, and can be used over a wide range of operating temperatures.

On the debit side, cast phenolic asbestos pipe is heavy, weak and fairly brittle. Moreover, phenolic asbestos is quite expensive, especially for fittings in the larger pipe sizes.

Haveg also markets pipe and fittings made of furane asbestos (Haveg 60, 61) which overcomes one specific draw-back of phenolic asbestos—lack of resistance to alkalis. Except for the nominally higher strength of the furane asbestos, mechanical and physical properties of the two types of pipe are essentially equal.

Until recently, Haveg also produced carbon-filled varieties of phenolic and furane resin pipe which, unlike the asbestos grades, were resistant to hydrofluoric acid. These types of pipe had poor mechanical properties and consequently were discontinued when Haveg developed a new superior fluoride resistant pipe material consisting of graphite-filled epoxy resin (Haveg 93).

Polyester Glass Improvements

Pipe of general purpose polyester resins reinforced with glass has high strength, good chemical resistance (except to alkalis), and is not subject to cold flow. Although such materials can resist fairly high temperatures for short periods of time, prolonged exposure to heat causes appreciable loss in strength, notably in water service. Under these conditions the pipe tends to develop slow weeping type leaks and at higher stress levels it creeps and eventually ruptures.[13, 14] This is attributed to a combination of porosity, poor resin-glass bonding, and to resin degradation with time, temperature and immersion as the variables.

In addition to the general purpose polyesters there are specialty materials within this chemical class which have properties similar to and sometimes exceeding those of epoxies. One of these is Atlac 382 (Atlas Powder) a bis-phenol derivate, used in the manufacture of Spiral-Glas pipe.

Another drawback of conventional polyester pipe is lack of adequate fittings and methods of joining, notably in the larger pipe sizes. Consequently, applications of polyester-glass materials in the process industries are restricted largely to low-pressure equipment.

Limited amount of polyester-glass pressure pipe still made is losing out to the more recently developed epoxy-glass pipe which, though somewhat more expensive, offers all-around improvement. Superiority is due to generally better physical, chemical and mechanical properties of epoxy resins.

Epoxy-Glass: Best All Around

Glass-fiber-reinforced epoxy pipe, developed about five years ago, has the highest strength and, except for the fluorocarbons, also the highest operating temperature in the plastic pipe field.

The strength-to-weight ratio compares favorably with metals, but the high strength cannot always be fully exploited because of pressure limitations of some of the currently available fittings and joining techniques.

Epoxy-glass pipe has high-impact strength, outstanding resistance to chemicals and weathering, and is not subject to cold flow.

Epoxy-glass materials are adversely affected by extended exposure to water at high temperatures, but to a far lesser extent than glass-reinforced general purpose polyesters.

Values quoted for physical and mechanical properties vary considerably among different manufacturers, and strongly depend on amount, type and orientation of the glass reinforcement, resin formulation and manufacturing technique. Epoxy-glass pipe is still largely a specialty item and fairly expensive, but its outstanding properties and good service experience promise a growing amount of industrial applications. At present, three U. S. companies are producing epoxy-glass pipe on a commercial scale. Bondstrand (Amercoat) and 3M Brand Pipe (Minnesota Mining) are manufactured by mandrel wrapping; Fibercast (Youngstown Tube and Sheet) is produced by casting techniques. A. O. Smith Corp. and Food Machinery and Chemical are currently in the development stage of perfecting their own brands of epoxy-glass pipe.

In addition to cast or laminated pressure pipe, epoxy resins and glass cloth are also employed as external reinforcing agents for glass pipe, chemical porcelain pipe and impregnated graphite pipe.

Thermosetting laminates of filled phenolic or melamine resins, known by a variety of proprietary names such as Formica, Micarta, Spauldite etc. are produced in tubular form. Although used to a limited extent in chemical plant application, such tubing is commonly employed in mechanical and structural applications. Unfilled phenolic tubing is not used commercially for pressure services because of extreme brittleness.

Piping based on furfuryl alcohol (furane) resins reinforced with glass or nylon cloth is produced commercially in sizes up to 48-in. It has good resistance to chemicals, temperature and thermal shock as well as sufficient toughness to make it useful in relatively low pressure applications such as chemical sewer service. Pipe of this description is marketed by Maurice A. Knight Co. as Permanite. Recently, Haveg entered the field with a competitive product designated Haveg 6610.

New Thermoset Development

A new thermosetting resin developed by Esso Research and Engineering looks promising for reinforced plastic pipe, judging from test results with experimental sections of 2-in. dia. glass reinforced pipe.[15]

This all-hydrocarbon resin, presently colled "C-oil," is a butadiene-styrene copolymer possessing high strength, good chemical resistance and exceptionally low water absorption characteristics. Its hydrophobic nature is a particularly attractive feature for application in glass-reinforced pipe, since water infiltration into the matrix tends to weaken the resin-to-glass bond. This has been found to be one of the shortcomings of polyester-glass pipe and to a lesser extent with epoxy-glass pipe. C-oil resin, currently in the pilot-plant stage, is expected to be less expensive than either polyester or epoxy resins, once commercial production gets under way.

Room-Temperature Chemical Resistance: Plastics Complement Metals—Table I

	Poly-ethylene	CAB (b)	ABS (a)	PVC	Saran (c)	Polyester Glass (d)	Epoxy-Glass	Phenolic Asbestos	Fluoro-carbons	Carbon Steel	12 Cr Steel
10% H_2SO_4	Excel.	Good	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Poor	Poor
50% H_2SO_4	Excel.	Poor	Excel.	Excel.	Excel.	Good	Excel.	Excel.	Excel.	Poor	Poor
10% HCl	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Poor	Poor
10% HNO_3	Excel.	Poor	Good	Excel.	Excel.	Good	Good	Fair	Excel.	Poor	Good
10% Acetic	Excel.	Good	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Poor	Fair
10% NaOH	Excel.	Fair	Excel.	Good	Fair	Fair	Excel.	Poor	Excel.	Excel.	Excel.
50% NaOH	Excel.	Poor	Excel.	Excel.	Fair	Poor	Good	Poor	Excel.	Excel.	Excel.
NH_4OH	Excel.	Poor	Excel.	Excel.	Poor	Fair	Excel.	Poor	Excel.	Excel.	Excel.
NaCl	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Fair	Fair
$FeCl_3$	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Poor	Poor
$CuSO_4$	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Poor	Good
NH_4NO_3	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Good	Excel.	Fair	Good
Wet H_2S	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Fair	Fair
Wet Cl_2	Poor	Poor	Excel.	Good	Poor	Poor	Poor	Excel.	Exed.	Poor	Poor
Wet SO_2	Excel.	Poor	Excel.	Excel.	Good	Excel.	Excel.	Excei.	Excel.	Poor	Poor
Gasoline	Poor	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.
Benzene	Poor	Poor	Poor	Poor	Fair	Good	Excel.	Excel.	Excel.	Excel.	Excel.
CCl_4	Poor	Poor	Poor	Fair	Fair	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.
Acetone	Poor	Poor	Poor	Poor	Fair	Poor	Excel.	Poor	Excel.	Excel.	Excel.
Alcohol	Poor	Poor	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.

Ratings are for long-term exposures at ambient temperatures (less than 100 F.)
(a) Acrylonitrile-butadiene-styrene polymer.
(b) Cellulose-acetate-butyrate.
(c) Chemical resistance of Saran-lined pipe is superior to extruded saran in some environments.
(d) Refers to general-purpose polyesters. Special polyesters have superior resistance, particularly in alkalis.

Plastic Corrosion: Go or No-Go

Plastic pipe has excellent chemical resistance, particularly against dilute mineral acids—areas where many metal alloys are vigorously attacked. However, plastics do not corrode in the same sense as metals.

Corrosion is not a good word to use with plastic materials. They are not attacked in a manner similar to metals.

The great majority of corrosion reactions on metals are of an electrochemical nature (corrosion by dry gases is an exception). Metallic corrosion is predominantly in the form of metal loss by uniform thinning or localized pitting, and generally progresses at a fairly constant rate expressed in terms of penetration.

How It's Attacked

In contrast to this familiar concept of corrosion, plastic materials "corrode" by direct chemical reaction or by solvation.

In direct chemical attack, the surface of the material reacts with the environment and is progressively destroyed; this is caused primarily by certain inorganic chemicals such as concentrated acids and strong oxidizing agents.

Solvation is the far more prevalent mode of attack. It involves penetration of a corrosive fluid into the interior of the material. This causes softening and swelling of the plastic (usually accompanied by weight gain) and commonly results in serious deterioration of physical and mechanical properties.

Solvation occurs almost exclusively with organic compounds and is most severe with esters, ethers, ketones, aromatic hydrocarbons and chlorinated solvents.

Attack of plastic materials is commonly of the "go or no-go" variety—they will either be completely resistant or suffer rapid deterioration. It is therefore impractical to use conventional corrosion rates for evaluating plastics in a given environment, especially when dealing with solvation reactions. In place of penetration rates, resistance of plastics is usually determined by other physical measurements such as volume increase, weight gain and change in physical properties.

Chemical resistance tests on plastics generally give more reliable results than corrosion studies with metals — performance of plastic materials is independent of such factors as solution impurities (inhibitive or promotive) passivation, protective films, galvanic effects.

In addition to direct chemical at-

18 Cr-8 Ni Steel	Monel	Copper	Yellow Brass	Aluminum	Impregnated Graphite	Hard Rubber (Buna N)
Poor	Good	Fair	Poor	Fair	Excel.	Excel.
Poor	Good	Fair	Poor	Poor	Excel.	Excel.
Poor	Fair	Poor	Poor	Poor	Excel.	Excel.
Excel.	Poor	Poor	Poor	Fair	Excel.	Fair
Good	Good	Fair	Poor	Excel.	Excel.	Excel.
Excel.	Excel.	Fair	Fair	Poor	Excel.	Good
Excel.	Excel.	Fair	Poor	Poor	Excel.	Fair
Excel.	Poor	Poor	Poor	Good	Excel.	Excel.
Good	Excel.	Good	Good	Good	Excel.	Excel.
Poor	Poor	Poor	Poor	Poor	Excel.	Excel.
Excel.	Fair	Poor	Poor	Poor	Excel.	Excel.
Excel.	Poor	Poor	Poor	Good	Excel.	Excel.
Good	Good	Poor	Fair	Excel.	Excel.	Excel.
Poor	Poor	Poor	Poor	Poor	Good	Fair
Fair	Poor	Good	Poor	Good	Excel.	Excel.
Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.
Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.
Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Fair
Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Good
Excel.	Excel.	Excel.	Excel.	Excel.	Excel.	Excel.

tack and solvation, some plastics are also subject to stress cracking in certain environments.[16] The most familiar example is the cracking of stressed polyethylene in the presence of certain soaps and detergents (Type III polyethylene pipe is more resistant to this type of attack than Type I).

Plastics Supplement Metals

The excellent chemical resistance of plastic pipe is probably its most attractive feature to the chemical process industry. Practically any of the plastics, even ordinary inexpensive polyethylene garden hose, can safely convey many extremely corrosive solutions that otherwise would require use of expensive alloys or nonmetallics. Also, plastics are less likely to cause product contamination and discoloration.

Degree of resistance of plastic pipe against a variety of substances at ambient temperature is given in Table I, together with ratings for several metallic and other nonmetallic pipe materials.

Ratings are considered to be conservative and may therefore disagree substantially with the over-optimistic or outright irresponsible service recommendations contained in some brochures.

Inspection of Table I reveals one interesting fact. Plastics and metals broadly supplement one another, each performing exceptionally well in environments quite detrimental to the other. For example, dilute mineral acids and aqueous solutions of acid salts ($FeCl_3$) are notoriously corrosive to most common metals, but have hardly any effect on most plastics. However, highly concentrated mineral acids (not included in Table I) and strong alkalis have a deteriorating effect on most plastics, but can be readily handled in ordinary metals such as carbon steel (H_2SO_4, NaOH) and aluminum (HNO_3). Also, metals clearly outperform plastics in resisting organic substances.

Weathering Shortens Life

Notwithstanding the excellent chemical resistance of plastic materials, they are subject to accelerated deterioration in outdoor atmospheres, called "weathering."

Characteristic effects of weathering cause impairment of physical properties such as strength, ductility and impact resistance. Although weathering resistance varies between different types of plastics, all of them experience shortened life when exposed to the combined effect of sunlight, oxygen and moisture.

Since plastics are essentially inert to air and water, the phenomenon of weathering is associated principally with the detrimental effect of ultraviolet radiation. A common method of improving the resistance to sunlight is to use opaque additives (carbon black).

Because of its electrical insulating quality, plastic pipe is immune to soil corrosion, regardless of moisture and acidity, or the presence of stray currents. This excellent resistance to underground corrosion (also microbiological) avoids need for external protection such as coating and wrapping for buried plastic lines.

Plastic materials are fairly resistant to ionizing radiation. Therefore they are useful in conveying radiochemical substances. Also, they are generally more easily decontaminated than other materials, including metals.[17]

Use With Caution

A word of caution to warn against the indiscrimiante use of ratings in the resistance table.

Such tables are intended to serve as guides in preliminary screenings of possible materials, and should not be used in making a final material choice. This caution is especially pertinent to metallic materials because electrochemical corrosion may be greatly affected by traces of moisture, solution impurities, aeration, etc. For example, carbon tetrachloride is essentially inert to metals in the dry state, but may be severely corrosive in the presence of liquid water.

Remember in using Table I: ratings apply strictly to room temperature conditions. Respective ratings for plastics at higher temperatures are to be found in published literature and manufacturer's bulletins.

Cost Determines Final Choice

Plastic pipe generally costs less than corrosion-resistant metals: most thermoplastics cost twice as much as carbon steel and thermosets run even higher. But stainless alloys are about 10-20 times the cost of steel.

The time-worn phrase that the dollar sign is the most important symbol in engineering calculations assumes new significance in the plastic piping field because of a very large number of competing materials.

For practically any given application, there are several types of plastic pipe with suitable properties; consequently, the final choice is heavily governed by economic considerations.

Such a highly competitive situation depresses prices throughout the plastic pipe industry, and tends to be most drastic with newly developed products attempting to enter the market. New types of pipe are frequently sold and installed at an appreciable loss to the manufacturer. He is willing to sacrifice immediate profit for an opportunity to gain publicity and establish reputation through commercial service experience.

List vs Discount Prices

Underselling of the form described above coupled with normal competition among standard products makes accurate pricing a most difficult task.

Discount rates fluctuate widely with time, locality, inventories and, of course, between individual manufacturers and distributors. In view of the highly mobile price structure, list prices are used as the common cost denominator. Figures given in Table III are representative list prices and as such, higher than the range of prices generally quoted by manufacturers and suppliers. Data are based on quantities of several hundred lineal feet and do not include cost of fittings, valves or installation. Prices shown are 1958 list prices.

Compare With Price Indexes

Although the cost data in Table III may be unrealistic on an absolute scale, it serves as a fairly reliable guide to comparative costs. It may be more significant, therefore, to interpret these figures as "price indexes" relative to standard weight carbon steel pipe.

Note that the price indexes are numerically equal to the actual dollar/ft. costs since the price of 3 in. Sch. 40 carbon steel pipe can be taken as $1/ft.

As a further refinement in establishing comparative costs, price indexes should preferably be based on equivalent strength rather than on equal thickness. This can be readily accomplished by dividing price indexes listed by the allowable pressure ratings of the respective materials. These adjusted price indexes are a more valid basis for cost comparisons of materials of vastly different strengths (thermoplastics and stainless alloys). Such adjusted indexes take into account the fact that alloy pipe or tubing can be many times thinner than competing plastic pipe for any given installation.

It should be stressed that the price indexes tabulated are valid only for 3 in. pipe, and may be considerably different for larger or smaller sizes.

The extent to which shifts in the price index scale may be affected by pipe size is illustrated by phenolic asbestos: the price index is less than 4 for 12-in. dia., but over 10 for ½-in. With extruded thermoplastics, price indexes remain essentially constant and independent of diameter—cost is nearly proportional to weight, similar to carbon steel.

Economics Favor Plastics

Industrial grade (reprocessed) polyethylene is the lowest priced process piping. And not only among plastics but also compared to any metal. The fact that polyethylene is competitive with ordinary carbon steel or cast iron pipe is undoubtedly a major reason for the widespread and still growing use of this versatile material.

Two other extruded thermoplastics commonly employed in the chemical and allied industries (ABS and PVC) are approximately double that of steel. Thermosets are more expensive than common thermoplastics. They run as high as ten times the cost of steel in the small diameters (phenolic asbestos). Glass-reinforced thermosets are less expensive, with price indexes ranging from about 2½ to 5.

Carbon-steel pipe lined with plastic or rubber is fairly reasonable (about $2-$5/ft.) except for Teflon lined pipe which sells for nearly $20/ft.

The generally favorable economics

How Much to Install Pipe?—Table II

	Wall, In.	Cost Ratios* Fittings/ Pipe	(Installation Labor)/Pipe	(Installed Pipe + Fittings)/Pipe = p Factor
Polyethylene (Type I)	0.154	0.15	1.1	2.3
Butyrate (CAB)	0.125	0.10	0.8	1.9
ABS polymer	0.154	0.10	0.7	1.8
Polyvinyl chloride (PVC)	0.154	0.15	0.7	1.8
Vinylidene chloride (saran)	0.218	0.10	0.4	1.5
Polyester-glass	0.50	0.27	0.25	1.5
Phenolic asbestos	0.50	0.36	0.25	1.6
Carbon steel	0.154	0.15	1.75	2.9
Cast iron	0.154	0.08	1.1	2.2
Copper K	0.083	0.08	0.75	1.8
Type 304 stainless	0.065	0.15	0.45	1.6

* Based on 100 ft. of 2 in. pipe in 20 ft. sections, three 90° ells, one 45° ell, two tees and two couplings. In cases where these items are not applicable, equivalents are used. Based on May 1955 prices. Table adapted from Ref. 18

of plastic or plastic-lined piping for severely corrosive service applications is apparent if you compare price indexes with those of various corrosion-resistant alloy materials.

Chrome-nickel stainless steels and high-nickel alloys (nickel, Monel, Inconel) are about 10-20 times as expensive as carbon steel pipe; special corrosion resistant metal or alloy pipe, such as the Hastelloys, titanium, tantalum and zirconium are even costlier, some in excess of $100/ft. However, in fairness to metallic materials, it must be reemphasized that a fair cost comparison of plastic and metal pipe should be based on the minimum schedule wall required for a given service, not on equal pipe wall thickness.

What About Installed Costs?

Cost studies indicate that shelf cost of pipe is usually less than one-half the installed cost of a piping system consisting of pipe, fittings and valves. Results of a simple study of this kind are presented in Table II. This is based on figures published by the Monsanto Chemical Co.[18] The p factor multiplied by shelf pipe cost gives an estimate of installed cost of pipe and fittings. Note this study omits cost of valves; it is estimated that inclusion of valves would raise the p factor by 25% or more. Also note the cost ratios given apply specifically to 2-in. dia. pipe; it can be assumed, however, that these values are reasonably valid for all small pipes sizes up to and including 4 in.

Actually, the costs shown in Table II are based on 100 ft. of pipe, in 20-ft. sections, three 90° ells, one 45° ell, two tees and two couplings; and on May 1955 prices and labor costs.

Not for Polyethylene

The cost factors in Table II are not valid for polyethylene pipelines, because they involve low labor and fitting costs (not counting burying). Polyethylene, now available in continuous coils of several thousand feet, can be laid like cable. It generally requires only about two or three fittings per mile.

It is interesting that p factors are inversely related to pipe cost. Carbon steel, cast iron, etc. have the highest factors, expensive pipe

Compare Costs of Plastics (3-In. Pipe)—Table III

	Cost ($/ft.) or Price Index (C.S. = 1.00) (a)			
	Sch. 10 (0.120 Ins)	Sch. 40 (0.216 In.)	Sch. 80 (0.300 In.)	Wall thickness as indicated par. (in.)
Plastics and metals				
Polyethylene (reprocessed), Type I		0.85		1.45(0.340)
Polyethylene (virgin), Type I		1.28		2.16(0.340)
Polyethylene (virgin), Type III		1.31		
ABS polymer		1.96	2.65	
Rigid PVC (Type I or Type II)		1.96	2.65	
Butyrate (CAB)		2.00		
Vinylidene chloride (saran)				4.60(0.329)
Phenolic asbestos (Haveg)				4.92(5/8)
High-impact styrene pipe				0.37(3/16)
Epoxy-glass (Fibercast J-500)				3.28(0.24)(b)
Polyester-glass, (Spiral-Glas)				2.52(1/8)(b)
Flexible PVC tubing (Tygon)				5.50(1/4)
Carbon steel (A-53, Gr. A)		1.00	1.52	
Cast iron (150 lb.)				0.95(0.35)
Galvanized carbon steel		1.20		
Stainless steel (Type 304)	5.95	9.12		
Stainless steel (Type 316)	9.72	14.88		
Aluminum (3003-F)		1.19		
Lead (antimonial)				1.74(3/16)
Monel	7.27	12.57	16.32	
Nickel A	8.78	15.20	19.87	
Inconel	10.54	18.11	24.02	
High silicon iron (Duriron)				3.90(5/16)
Stainless alloy 20	17.30			
Hastelloy B	22.70			
Tantalum tubing (c)				115.00(0.025)
Titanium (A-55)		58.50		
Lined carbon steel				
Rigid PVC lined (Jal-Jacket)	1.96(d)(0.065)			
PVC plastisol dipped (e)		3.55(1/8) (d)		
Saran-Lined		4.73(3/16)(d)		
Teflon lined (Fluroroflex-T, Type S)		17.20(0.070)(d)		
Hard-rubber lined		3.32(1/8)(d)		
Neoprene lined		4.23(3/16)(d)		
Coal-tar lined (centrif.)		1.30(1/8)(d)		
Cement lined (centrif.)		1.30(3/16)(d)		
Glass lined		14.90(0.050)(d)		
Nonmetallics (other than plastics)				
Impregnated graphite (Karbate)				8.00(1/2)
Glass (Borosilicate)				4.30(0.203)
Asbestos cement (Transite 150 lb.)				0.95(0.50)
Chemical stoneware				2.10(3/4)
Chemical porcelain				2.90(3/4)
Hard rubber				4.00(3/8)

(a) Dollar cost and price index are identical because carbon steel costs approximately $1.00/ft
(b) Total wall thickness, including nonreinforced surface layers.
(c) Figures refer to 2 in. thin-walled tubing, the largest size manufactured.
(d) Prices include cost of steel pipe; parenthesized figures refer to lining thickness.
(e) Pipe coated internally and externally.
Note: Cost comparison for plain end or screwed pipe, 1958 list prices, based on several hundred ft. Cost of fittings, valves and installation not included.

Plastic Pipe: Thickness and Diameter Variety—Table IV

		Nominal Pipe Size (In.) 1	2	3	4	6
Schedule A	O.D.	1.315	2.375	3.500	4.500	.....
	I.D.	1.195	2.175	3.220	4.110	.....
	W.T.	0.060	0.100	0.140	0.195	.....
Schedule B	O.D.	1.315	2.375	3.500	4.500	.....
	I.D.	1.165	2.125	3.140	4.040	.....
	W.T.	0.075	0.125	0.180	0.230	.....
Schedule 40 (I.P.S.)	O.D.	1.315	2.375	3.500	4.500	6.625
	I.D.	1.049	2.067	3.068	4.026	6.065
	W.T.	0.133	0.154	0.216	0.237	0.280
Schedule 80 (I.P.S.)	O.D.	1.315	2.375	3.500	4.500	6.625
	I.D.	0.957	1.939	2.900	3.826	5.761
	W.T.	0.179	0.218	0.300	0.337	0.432
Schedule 120 (I.P.S.)	O.D.	1.315	2.375	3.500	4.500	6.625
	I.D.	0.915	1.875	2.800	3.626	5.501
	W.T.	0.200	0.250	0.350	0.437	0.562
S.W.P. (Solvent welded pipe)	O.D.	1.140	2.250	3.250	4.100	6.220
	I.D.	1.000	2.000	3.000	3.800	5.760
	W.T.	0.070	0.125	0.125	0.150	0.230
100 lb. class pressure rated pipe, CS197-57 Series 3 Type I polyethylene)	O.D.	1.409	2.777	.....	.....	.....
	I.D.	1.049	2.067	.....	.....	.....
	W.T.	0.180	0.355	.....	.....	.....
100 lb. class pressure rated pipe, S.W.P.-O.D. (Type I ABS)	O.D.	1.140	2.250	3.250	4.100	6.220
	I.D.	1.020	2.060	2.980	3.760	5.700
	W.T.	0.060	0.095	0.135	0.170	0.260
100 lb. class pressure rated pipe, S.W.P.-O.D. (Type II ABS)	O.D.	.....	2.250	3.250	4.100	6.220
	I.D.	.....	2.100	3.070	3.880	5.900
	W.T.	.....	0.075	0.090	0.110	0.160

materials have low values. This is logical because cost of installation relative to material cost is proportionately higher for the low priced materials. Also evident is the exceptionally high cost of phenolic-asbestos fittings, which was mentioned previously as one of the drawbacks of phenolic-asbestos piping installations.

Also Fringe Benefits

In general it can be concluded that plastic piping appears to be economically attractive, especially as an alternate to high-alloy materials. Plastic pipe offers a number of fringe benefits which further enhance its favorable economics relative to metals. These are low shipping and materials handling costs; savings on thermal insulation as well as on external corrosion protection (painting, coating, wrapping, cathodic protection); and finally, increased on-stream time due to the speed and ease of installation and maintenance in process installations.

All About Pipe Sizes and Fittings

A multitude of pipe sizes and fittings are available for plastic pipe, and supply is good. But there is an urgent need for standards on sizes.

Plastic pipe is manufactured in a bewildering array of diameters, lengths, wall thicknesses and fitting dimensions.

Range of standard lengths and diameters of plastic pipe are tabulated in the right hand column of Table IV. In the majority of cases, maximum lengths listed are standard pipe lengths commercially available; however, longer sections can frequently be furnished on special request.

A notable example is the recent introduction of continuous polyethylene coils up to several thousand feet long. Similarly, diameters are not necessarily limited to the ranges shown. Thermoplastics can be custom ordered in extra large sizes but may be more difficult to obtain because special, expensive dies are required.

Bewildering Array

The oldest and still widely used method of designating wall thickness is the standard I.P.S. (Iron Pipe Size) schedule system. Recently, Schedules A and B have joined the heavier standard Schedules 40, 80 and 120.

A second system for defining wall thickness is the S.W.P. (solvent weld pipe) system. This is coming into more widespread use with the growing popularity of solvent weld jointing by means of slip-sleeve fittings. All S.W.P. thicknesses were set up to be considerably thinner than Sch. 80, or even Sch. 40, on the reasoning that absence of threads leaves the entire wall thickness available for mechanical strength.

Third and most recent method is

based on maximum recommended pressure ratings, similar in principle to the long established system of classifying cast iron and asbestos-cement (Transite) pipe. Pressure-rated pipe dimensions are defined as S.W.P.-O.D., I.P.S.-O.D., or for polyethylene as I.P.S.-I.D.

Dimensional differences in I.D., O.D. and wall thickness for the three systems is illustrated in Table IV. Introduction of pressure rated pipe has brought with it considerable confusion and has further impeded the standardization of plastic pipe dimensions.

The obvious reason for this is that wall thicknesses in a given pressure class are not fixed dimensions, but variables depending on the long-term working stress of the specific material. Thus, for example, the wall thicknesses of 2-in., 100 lb. pressure-rated pipe are 0.355 in., 0.095 in. and 0.075 in. respectively for Type I polyethylene, Type I ABS and Type II ABS pipe.

This confusion is further compounded. Pipe extruders do not agree on allowable working stress for a given material. For example: figures quoted for long-term allowable hoop stress for Type II ABS range from 1,400 to 2,000 psi.

In thermoset piping, there is a total absence of standard schedules. Wall thicknesses are presumably adequate to sustain extended operation at maximum allowable pressure ratings.

In comparing advertised thicknesses of glass-reinforced pipe, pay attention to difference between total thickness and the reinforced thickness, which carries the load.

Fittings Are Fairly Complete

A fairly complete line of plastic fittings is currently available for the common types of thermoplastic pipe.

Fittings are made of the same materials as the pipe, except with polyethylene where insert fittings must be harder and stiffer than the pipe itself

For thermosetting pipe, available fittings are considerably more limited. This lack of adequate fittings is a big problem in larger sizes of polyester-glass and epoxy-glass pipe.

Selection of fittings available in common thermoplastics include all the standard types: elbows, bends, tees, crosses, wyes, couplings, nipples, caps, bushings, plugs unions, flanges, and a variety of metal-to-plastic connector fittings.

Most of these fittings may be ordered with either plain, screwed, socket or flanged ends (see Table VII); grooved end Victaulic (Victaulic Co. of Amer.) fittings are also available. In addition to solid plastic construction, plastic or rubber-lined metal fittings are frequently used in plastic piping systems. More recently, plastisol-dipped metal fittings have come on the market.

Supply Is Good

It is only fairly recently that an adequate selection and supply of fittings has become available, principally because high manufacturing costs of injection molding facilities discouraged commercial production.

Another obstacle responsible for the slow growth of the plastic fittings industry is lack of dimensional standardization, creating need for huge inventories. This aspect continues to be an economic problem to the point where several of the large producers currently manufacture as many as 900 different sizes and types in each of several different types of plastics.

Plastic fittings are produced by several different methods. Cheapest and simplest is extrusion (with subsequent machining) but it is obviously adaptable only for making simple straight components such as couplings.

By far the most widely used manufacturing method for thermoplastic fittings is injection molding. The high cost of this technique practically restricts sizes of fittings produced and stocked to the common pipe sizes, that is, ½ through 4 in.

Fittings for larger diameter pipe are custom fabricated by a combination of machining and welding operations, either of the heat or solvent weld kind. Thermosetting fittings of all sizes are usually produced by techniques similar to those used in manufacturing pipe.

Valves Come in Large Variety

There are a great many different types and designs of valves customarily used in plastic piping systems.

All-plastic plug, globe, check, ball and diaphragm valves are manufactured in a variety of thermoplastic materials by injection molding and/or fabrication production techniques.

Allied Chemical

Molded thermoplastic valves are generally produced and stocked only in the smaller size ranges (up to 3 in.) for the same economic reasons previously cited in connection with fittings.

Phenolic asbestos is the only one of the thermosetting pipe materials used in the manufacture of valves. Recently, the Duriron Co. introduced a line of metal-armored plastic valves manufactured from filled epoxy casting compounds (Durcon).

Large valves are both difficult and expensive to fabricate exclusively in plastic. Consequently, valves for large diameter piping are usually all or part metal.

Since large solid-alloy valves are very costly, designs combining plastic or rubber-lined steel bodies and corrosion-resistant trim find wide application.

Probably the oldest and most widely used design of this type is the simple pinch-clamp or diaphragm valve produced under the Saunders patent by both Hills-McCanna and Grinnell. Large diaphragm valves, some up to 18 in., can be ordered with a combination of body construction (solid alloy, lead-lined, rubber-lined, plastic-lined or coated, glass-lined) and diaphragm materials (hard and soft rubber, polyethylene, PVC, Teflon, Kel-F).

Important Physical and Mechanical Properties (73.4F.)—Table V

	Specific Gravity	Flexural Strength, Psi.	Compressive Strength, Psi.	Modulus of Elasticity, 100,000 Psi.	Impact Strength, Izod Notch, Ft.-Lb./In.
Polyethylene (Type I and II)	0.910–0.940	1,700–3,700	—	0.2–0.6	Over 15
Polyethylene (Type III)	0.941–0.965	3,700–6,600	—	0.6–1.7	1.2–12
Cellulose acetate butyrate (Tenite butyrate)	1.2	5,700–6,200	5,700–6,300	1.2–1.4	1.0–3.0
Acrylonitrile-butadiene-styrene (ABS Type I)	1.04–1.07	7,000–8,000	5,000–7,000	1.8–3.0	4.0–9.0
Acrylonitrile-butadiene-styrene (ABS Type II)	1.06–1.08	12,000	10,000	3.5–4.0	4–6
Vinylidene chloride (saran)	1.7	4,000–7,000	7,500–8,500	0.4–0.8	0.3–1.0
Polyvinyl chloride (PVC Type I)	1.35–1.45[c]	12,000–17,000	8,000–11,000	4.0–5.4	0.6–0.9
Polyvinyl chloride (PVC Type II)	1.35–1.45	9,500–11,500	8,000	2.5–3.5	8–18
Phenolic asbestos (Haveg)	1.7	6,500	10,000–14,000	8.7	0.48
Polyester (glass reinforced)	1.5–2.0	Up to 65,000	Up to 40,000	Up to 30	Over 10
Epoxy (glass reinforced)	1.7–2.2	Up to 80,000	Up to 60,000	Up to 50	Over 10
Carbon steel (A53, Grade A)	7.8	—	48,000	300	Excellent
Stainless steel (18 Cr-8 Ni)	8.0	—	75,000	280	Excellent
Copper (seamless annealed)	8.9	—	30,000	170	Excellent
Aluminum (annealed 3003)	2.7	—	14,000	100	Excellent
Borosilicate glass	2.2	1,000	100,000–180,000	98	Poor
Impregnated graphite (Karbate)	1.9	4,700	9,000	23	Poor
Hard rubber (Buna N)	1.2–1.5	11,000	7,000–12,000	3.0	0.3–0.4

Dash indicates property not applicable. Blank indicates data not available.
Values for plastics are flexural modulus; for other materials, tensile (Young's) modulus is listed.
ASTM test results referring to thermoplastics: Specific gravity, D-792; Flexural strength, D-790; Elasticity modulus, D-638; Impact strength, Izod notch D-256; Deflection Temperature, D-648; Coeff. of thermal expansion, D-696; Flammability, D-635, Compressive strength, D-695
[a] Straight lengths in 4 in. and 6 in. sizes; smaller sizes are furnished in coils up to 400 ft. long.
[b] Straight lengths in 3 in. to 8 in. sizes; smaller sizes are furnished in coils up to 400 ft. long.
[c] Pipe extruded from Montecatini Vipla resin (Ryertex-Omicron) has a specific gravity of 1.51 and a Deflection Temperature of 171–177 F.

All Important: Design Properties

Long-time service lowers working strength, most plastics will cold flow and high temperatures cause loss of strength and stability. All these properties must be allowed for.

Consideration of physical and mechanical properties is an important part of any plastic piping system design.

Tensile strengths, creep properties, temperature resistance, expansion, toughness, are quite different from metals.

In this section, the physical and mechanical properties of plastics are discussed individually, with specific reference to their significance and proper use in design.

To amplify the text, two charts are presented (Tables V, VI). These charts include comparative values of properties for some common metals and several nonmetallic piping materials other than plastics.

It is important to recognize that numerical values of the physical and mechanical properties of plastic materials strongly depend on test conditions and on the manner in which these characteristics are measured. Temperature and time under stress are of the utmost importance in determining strength properties; other factors which have an effect are geometry of the test specimen and loading rate.

To eliminate, or at least minimize, variations in measurements and to obtain values suitable for direct comparisons, standard ASTM test procedures have been widely adopted.

Respective ASTM tests for the tabulated properties given in Table V refer primarily to thermoplastics. Most manufacturers of reinforced thermosetting pipe generally devise and employ special test methods more suited to their products. These special tests are performed on an entire pipe section or assembly rather than a small specimen of the material, and also take into consideration the marked nonisotropic properties of laminated pipe.

Short-time Tensile Strength

Short-time tensile strength of thermoplastics is usually measured in an axial tension test performed on dumbbell-shaped specimens of rectangular cross section (ASTM D-638). With piping materials, however, it is common practice to determine short-time tensile strength indirectly, by applying Barlow's Formula to results from quick burst tests (ASTM D-1599-58T):

$$P = 2St/O.D.$$

where P = internal pressure, psi.; S = tensile (hoop) stress, psi.; t =

Deflection Temperature @ 264 Psi. Deg. F.	Max. Recommended Operating Temp., Deg. F.	Coefficient of Thermal Expansion 10^{-5} In./In./F.	Thermal Conductivity Btu./Sq. Ft./Hr./F./In.	Flammability, In./Min.	Standard Max. Pipe Length, Ft.	Standard Pipe Sizes, In. Dia.
105–120	120	6–14	1.8–2.3	0.9–1.1	25[a]	1/2-6
120–125	150	6–9	2.3–3.2	0.9–1.1	30[b]	1/2–8
145–155	140	6–10	1.1–2.2	1.3	20	1/2–8
185–190	170	3.0–6.0	1.0	1.0–1.3	20	1/2–12
205–225	180	3.8–5.6	1.0–1.8	1.3	20	1/2–12
130–150	150	7–11	0.6–0.9	Self-extinguishing	10	1/2–6
160–165(c)	150	2.9–6.7	0.8–1.2	Self-extinguishing	20	1/4–12
150–155	140	6–14	1.3	Self-extinguishing	20	1/4–12
	265	1.1–1.8	3.0	Nonflammable	10	1/2–12
	200	1.2–4	1.5	S.-e. to s.b.[†]	20	1–12
	300	0.7–0.9	0.9–2.5	S.-e. to s.b[†]	20	2–8
—	1000	0.67	360	Nonflammable	20	1/4–24
—	1500	0.93	110	Nonflammable	20	1/4–24
—	400	0.95	2700	Nonflammable	20	1/8–12
—	400	1.3	1320	Nonflammable	20	1/8–10
—	450	0.18	8.0	Nonflammable	10	1–6
—	340	0.24	1020	Nonflammable	9	1–10
275	225	2.6–4.0	1.0	Burns slowly	10	1/4–8

† Self-extinguishing to slow-burning.

wall thickness, in.; *O.D.* = outside diameter, in.

Short-time tensile strength of plastics is generally well below that of metals, except in the case of some of the reinforced thermosetting resins where hoop tensile strengths up to 80,000 psi. are claimed. Tensile strength falls off with rising temperature; this drop-off is exceptionally sharp with thermoplastic materials. At the upper allowable temperature limits, the quick burst strengths fall off to about one-half of the respective room temperature values.

Short-time tensile strength is of limited practical value in the design of plastic structures. Plastics are subject to undue creep and/or failure by rupture at stress levels considerably lower than the ultimate strength determined in short-time tests. As will be shown later, values of short-time strength are useful primarily as a reference point for estimating long-term allowable (working) stresses for plastic pipe.

Stress Rupture Vitally Important

Under application of sustained tensile stress, plastic materials suffer a progressive decrease of strength and eventually fail at stress levels substantially lower than their short-time strength.

Metals are also subject to stress rupture (or creep rupture as it sometimes is called) but in contrast to plastics, gradual weakening with time is significant only at elevated temperatures.

Two principal variables governing stress rupture behavior of plastics are time and temperature. After 100,000 hr. (11.4 yr.), room temperature burst strength of common thermoplastic pipe materials is only about one-third of their quick burst strength.

Temperature greatly influences long-term strength (even more than short-term strength). Thus at the upper allowable temperature limits, the 100,000 hr. rupture stress is only about 10-15% of the respective quick burst strengths.[3] With Type II PVC, it may be even lower because failure is appropriately defined as the initiation of "weeping" which occurs 2-3 times sooner than actual rupture.

Time to failure by rupture for any one plastic material is dependent not only on temperature and stress level, but also on the size and geometry of the particular piping component or system. Consequently, reliable data on stress rupture behavior can be obtained only by long-time tests, preferably performed on typical piping assemblies.

When such long-term stress rupture data are not available, service life of thermoplastics can be roughly estimated by cautious extrapolation of data from short-time runs. This is based on an empirical fact. The relationship between fiber stress at failure and time to failure generally has been noted to follow the trend of a simple mathematical expression such as an exponential or logarithmic function. Latest thinking in the

Allowable Operating Stresses, Pressures, Temperatures for 2-In. Pipe—Table VI

	Pipe Wall Schedule	O.D., In.	I.D., In.	Wall, In.
Polyethylene (Types I and II)	Sch. 40	2.375	2.067	0.154
Polyethylene (Type III)	Sch. 40	2.375	2.067	0.154
Butyrate (Tenite Butyrate)	S.W.P.	2.250	2.000	0.125
Acrylonitrile-butadiene-styrene polymer (ABS Type I)	Sch. 40	2.375	2.067	0.154
Acrylonitrile-butadiene-styrene polymer (ABS Type II)	100# Class	2.250	2.100	0.075
Vinylidene chloride (saran)	Sch. 80	2.375	1.939	0.218
Polyvinyl chloride (PVC Type I)	Sch. 40	2.375	2.067	0.154
Polyvinyl chloride (PVC Type II)	Sch. 40	2.375	2.067	0.154
Phenolic asbestos (Haveg 31)	—	3.000	2.000	0.500
Polyester-glass (Spiral-glas)	—	2.180	1.930	0.125
Cast epoxy-glass (Fibercast J-700)	—	2.375	1.895	0.240
Laminated epoxy-glass (Bondstrand)	—	2.375	2.205	0.085
Carbon steel (seamless A53, Gr. A)	Sch. 40	2.375	2.067	0.154
Stainless steel (seamless, Type 304)	Sch. 40	2.375	2.067	0.154
Copper (seamless annealed)	Sch. 40	2.375	2.067	0.154
Aluminum (annealed 3003)	Sch. 40	2.375	2.067	0.154
Borosilicate glass	—	2.344	2.000	0.172
Impregnated graphite (Karbate)	—	2.750	2.000	0.375
Hard rubber (Buna N)	Sch. 120	2.375	1.875	0.250

[a] Values recommended by the Thermoplastic Pipe Division of the S.P.I.
[b] American code for pressure piping (ASA B. 31)
[c] Calculated from Barlow's Formula (ASA B. 31, Par. 324b) with zero corrosion allowance.
[d] First number is axial tensile strength; second number is hoop strength at burst.

thermoplastic industry favors the use of log-log plots in preference over Larson-Miller[30] type semi-log correlations for predicting time-to-rupture, because logarithmic plots are generally more linear.

Extrapolation Is Unreliable

However, stress rupture data predicted by such extrapolation methods is unreliable (equally true of metals) and of limited value for design calculations. As an illustration, recent studies with certain polyethylene resins [21, 29, 30] indicate stress vs. time to rupture plots remain linear only for the portion of the curve associated with ductile type failures. After longer exposures, failure occurs in a brittle manner (cracking or pin-holing) at stress levels significantly below those predicted by straight line extrapolation. This abrupt change in slope or "knee" is noted to be progressively shifted to the left (to lower time-to-failure) with increasing temperatures (see Fig. 1).

Present indications are that this knee-effect is not experienced with PVC or ABS materials; nevertheless, in setting long-time design stresses, it is inadvisable to extrapolate beyond one log cycle.

Correlation between short-time and long-time data has been refined in a recent study [24] by the discovery that room temperature stress rupture and creep behavior of rigid PVC pipe can be predicted from short-time stress relaxation tests.*

All Plastics Creep

All plastic materials under stress are subject to deformation by creep (viscoelastic strain), appropriately dubbed cold flow in plastics terminology because it occurs at ambient temperatures.

In this respect, plastic materials differ sharply from steel and other common metals (except lead and tin) which are subject to significant expansion by creep only at elevated temperatures. Creep deformation, similar to stress rupture, is a function of the three independent variables of time, stress and temperature. Although certain methods have been developed for predicting creep behavior from short-time tests,[24] reliable creep data can be determined only from long-time tests conducted at specified temperature and stress levels.

Results of one such investigation with Type I PVC[18] are reproduced in Fig. 2.

The linear nature of creep curves on log-log coordinates beyond 100 hr. indicates Type I PVC has a second stage creep behavior, qualitatively similar to that of steel. A sudden large increase of creep rate in the top curve immediately prior to stress rupture, described as third stage creep, is characteristic of ductile type failures. At lower values of temperature and loading time, Type I PVC will generally fail in a brittle manner with relatively small creep deformation.

Since creep strain of some thermoplastics, notably polyethylene, has been observed to go excessively high (sometimes over 50%), allowable design stresses cannot be based solely on stress rupture data but must also take into account dimensional stability.

* Stress relaxation is a measure of the progressive time-dependent decrease in stress required to maintain constant deformation in a specimen strained to some predetermined deformation (usually well below the yield point).

Short-Time Tensile Strength at 73.4 F., Psi.	Allowable Long-Time Hoop Stress at 73.4 F., Psi.	Allowable Working Pressure, Psi. At 73.4 F.	At Max. Oper. Temp.	Maximum Recommended Operating Temp., F.
1,400–2,500	385	50	24	120
2,500–5,100	600	75	29	150
5,000–5,500	700[a]	95	50	140
5,000–6,000	1,000[a]	75	40	170
7,500–8,500	1,400	100	25	180
4,000–7,000	800	125	50	150
6,400–9,000	1,200[a]	175	97	150
5,500–6,500	1,000[a]	156	25	140
2,250–4,500		150	110	265
29,000;58,000[d]		500	500	200
30,000;25,000[d]		700	350	300
40,000;8,000[d]		550	275	220
48,000	16,000[b]	1,820[c]	284[c]	1,000
75,000	18,750[b]	2,140[c]	86[c]	1,500
30,000	6,700[b]	765[c]	284[c]	400
14,000	3,350[b]	382[c]	205[c]	400
10,000		50	50	450
2,500		75	75	340
6,500–7,200	1,400	50	50	225

In piping systems, an allowed creep deformation of about 5-10% is considered a maximum practical limit. Both creep and stress rupture curves must be consulted to determine which of the two conditions govern in the design of a particular piping system. With certain thermoplastics, such as Type II ABS, and especially with reinforced thermosets, creep information is of secondary importance because brittle failure by stress rupture takes place at relatively low creep expansion (below about 5%).

What Stresses to Use?

A designer of plastic piping systems is vitally interested in stress levels which may be tolerated for prolonged periods without causing excessive deformation or failure.

Present practice in this country is to set long-term working stresses of thermoplastics at approximately 20% of their short-time tensile strength (based on quick burst tests) at any given temperature. This 5:1 scale-down factor is based jointly on experience and on extrapolation of short-term data. It is in line with the tentative recommendations of the SPI's Thermoplastic Pipe Div. for design stresses at 73.4F. (see Table VI).

These "long-term" values are not as conservative as would appear. A large part or all of the 5:1 factor is used up in adjusting for the progressive decrease of working strength under continuous load. Thus even at room temperature, the effective safety factor based on 100,000 hr. life reduces to about 1½:1, only half as large as the 3:1 mechanical safety factor on ultimate tensile strength imposed by the American Standard Code for Pressure Piping (ASA B.31) for seamless carbon steel pipe.

At elevated temperatures, the 100,000 hr. rupture stresses fall below 15% of the respective short-time strengths, indicating that design stresses based on 20% of the short-time burst strength are inadequate for 10 yr. life.

Allowable Pressure Controversy

Allowable working pressures for 2 in. pipe listed in Table VI (representative of recommendations by U. S. manufacturers) reflect different levels of conservatism. This is plainly illustrated by comparing typical "recommended" pressure ratings of Type II PVC and Type I ABS. Both use the identical long-term allowable hoop stress of 1,000 psi. at 73.4 F. But respective recommended pressure ratings differ by more than 2 to 1 (156 vs. 75 psi. for 2-in. Sch. 40).

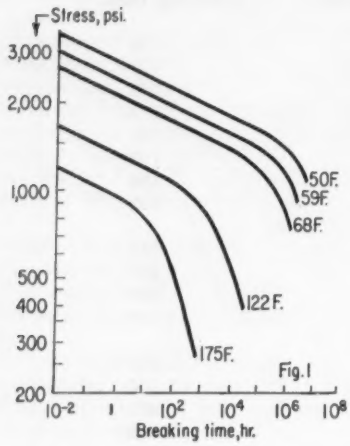
Suggested working pressures for thermoplastics at maximum operating temperature appear to be generaly too high, judged by the criteria discussed in the preceding paragraph. By way of illustration, the predicted 100,000 hr. burst pressure of Type I PVC at 150 F. is about 65 psi., compared to the recommended value of 97 psi.

With respect to thermoset piping, allowable pressure ratings are strictly up to the individual manufacturers. At low temperatures, design pressures recommended by producers of glass reinforced thermoset pipe fall between 10 and 20% of burst pressures determined in quick tests.

The apparent inadequacy of high-

Heat Wilts Plastic Strength[22]

(High-Density Polyethylene)



temperature pressure ratings recommended for some of the thermoplastics suggests that allowable design stresses and working pressures require critical reexamination.

Along that line of reasoning, the industry is beginning to adopt long-term test procedures at temperature in preference to short-time tests. Sansone[19] suggests reasonable safety factors ranging between 1.3 and 1.75, to be applied to 100,000 hr. burst stresses for thermoplastic pipe materials.

With newer materials such as Type II ABS, allowable pressure ratings currently suggested by different extruders show little agreement. Greater uniformity will be attained as soon as more extensive long-term data and service experience are accumulated and become incorporated into definitive standards and specifications of trade and technical societies. Until such time, the more liberal ratings should be viewed with skepticism. They apparently reflect lesser conservatism rather than superior products.

Before concluding this discussion, one more point should be made. Maximum allowable vacuum ratings cannot be reliably calculated. They are based on direct testing by individual manufacturers. In general, the stronger plastics, such as PVC can take full vacuum, except at elevated temperatures. Polyethylene has limited application under vacuum. But some glass-reinforced epoxy pipe has been specially designed for external loads up to several thousand psi.

Stiffness Needs Defining

Modulus of elasticity is a measure of stiffness and defined as the ratio of stress to unit strain.

In dealing with metals, it is common practice to use tensile stress (Young's Modulus); with plastics materials, the flexural modulus (ASTM D-638) is more frequently used.

Elastic modulus, whether in tension or flexure, is of limited value for designing plastic structures, because the elastic limit is generally extremely narrow relative to the plastic range. Moreover, the modulus of elasticity is not a constant, since strain (due to creep) is a function of both time and temperature. Thus, designers of plastic structures have found it expedient to define and use the concept of a time-dependent modulus to describe long-time creep behavior.

$E_t = S_o/e_t$

E_t = Time dependent modulus of elasticity (psi.)
S_o = Initial stress (psi.)
e_t = Strain at time t (in./in.)

Numerical values of time-dependent moduli may be calculated from experimental creep data, and can be used directly to evaluate strain for any given time and temperature.

Magnitude of E_t also depends on loading; experimentation with rigid PVC indicates that it is independent of loading only up to a certain critical stress value. Above that limit, the samples subjected to higher loadings have smaller moduli, indicating that strain is no longer directly proportional to stress.[25]

How Tough Are Plastics?

Impact strength is a measure of toughness or resistance to shatter (brittle failure).

The conventional method for determining impact resistance of plastic materials is by the standard Notched Izod Test (ASTM D-256). Such values are of questionable significance because this test measures a composite of properties such as elasticity, strength, ductility, and damping capacity.[26]

Another limitation is results apply only for the given standard specimen and, at that, only at one point on the energy absorption versus impact velocity curve. Consequently, neither the size or shape of the test specimen, nor the manner or sharpness of the blow is taken into account.

Impact strength is more of a relative and qualitative rather than absolute and quantitative measure of a plastic's toughness in actual use. For that reason also, direct numerical comparison between impact strength figures of plastics and metals cannot be considered significant. As a supplement to the Izod Test, the ASTM is currently developing a "ball drop" type test, considered to be a more reliable index of impact resistance under actual service conditions.

Room temperature impact strengths listed in Table V cover a wide range from a minimum of 0.3 to 15.0 ft.-lb./in.

Unfilled thermosetting resins are generally more brittle than thermoplastics, but with proper reinforcing materials this low-impact strength can be very radically improved.

Broadly speaking, plastics with Izod test values below 0.8-1.0 ft.-lb./in. are brittle; but this should not be interpreted as meaning impact failures of such materials are commonplace. For example, tests on Normal Impact PVC pipe (0.6–0.9 ft.-lb./in.) show a hard blow with a 10 lb. hammer is necessary to initiate failure by cracking.[27]

But Normal Impact PVC can be quite notch-sensitive, a characteristic to take into account in design of piping components and assemblies.

Threaded ends, sudden changes in cross-section, surface imperfections, and other similar points of stress concentration should be avoided wherever possible.

Similar to carbon steel, plastic materials have a drop-off in impact resistance with decreasing temperature. High Impact PVC suffers a loss of impact strength in excess of 90% at -40F, relative to its room temperature value. This lowering of impact resistance imposes a minimum working temperature limit for each plastic material. This limit is usually low enough to permit outdoor exposure in the U. S. since, with the exception of saran and Normal Impact PVC,

adequate impact resistance is maintained down to at least −20F.

Highly Over-Stated

While plastics are no match in toughness to metals, note that the so-called brittleness of plastics is highly over-estimated and should not be considered a serious deterrent to use of plastics. This conclusion emerges from an impartial field study covering nearly one million lineal feet of plastic pipe.[55] In 457 separate installations operated by companies experienced with plastic pipe (so-called routine users) only a single failure was attributed to mechanical shock out of a total of 22 failures reported. No failures of any kind were reported by the five largest routine users (585,000 total ft.).

A Major Disadvantage

One of the major drawbacks of plastic materials is softening, loss of mechanical strength and eventual resin deterioration at temperatures which are quite low compared to the upper temperature limitations of most metals.

For thermoplastic materials this lack of heat resistance is generally measured by the Deflection Temperature, (ASTM D-648). This is the temperature at which a standard test specimen attains a center deflection when subject to a constant stress while heated. Note that Deflection Temperature was formerly called Heat Distortion Point.

Deflection Temperatures are arbitrary values and cannot be interpreted literally as the maximum usable temperature for long-time service.

In general, a safe rule-of-thumb based on experience for most thermoplastic structural materials is to set the maximum working temperature about 10 to 20 F. lower than Deflection Temperatures at 264 psi. fiber stress.

Table VI shows the upper operating temperature limit for common types of thermoplastic pipe is less than 200 F. This imposes a severe limitation for chemical service applications where solutions are frequently handled at their normal boiling point.

Another problem caused by softening and lack of dimensional stability in the higher temperature ranges is need for closely spaced or continuous support of thermoplastic pipe. This is usually accomplished by resting the pipe on inverted angle irons.

Thermosets Are Better

In contrast to thermoplastics, thermosets offer appreciably better heat resistance. Both phenolic asbestos and reinforced epoxy pipe are recommended for service at temperatures in excess of 250 F.

Remember, however, that polyester resins (and to a lesser extent epoxy resins) are subject to deterioration and consequent impairment of mechanical properties after prolonged exposure to temperatures considerably below the maximum service temperatures.

High Expansion Rates

In comparison to metals, thermoplastic materials have very high expansion rates. Coefficients of expansion of thermoplastics are on the average at least five times, and in some instances as much as 20 times, larger than steel. Values for thermosetting pipe materials generally fall between those of thermoplastics and metals.

Excessive expansion rates of plastic pipe pose a design problem in systems operating at or near the upper temperature limit—especially if frequent thermal cycling is anticipated.

More Pipe Complications

Expansion problems in plastic piping are further complicated—it is virtually impossible to predict expansion characteristics of newly installed extruded pipe.[56] Upon first heating, such pipe will relieve itself of locked-up stresses produced by post-extrusion cold working in the manufacturing process. Depending on the direction and magnitude of these residual stresses, the pipe may expand more than calculated, not at all, or in some instances may even contract. This tendency of thermoplastic pipe to stress relieve itself is referred to as "memory" in plastic technology. It is fundamentally the same type of phenomenon familiar to the metallurgist, which produces warpage and distortion of severely cold worked metal parts after heat treating.

Plastic substances are excellent thermal and electrical insulators. Representatives values of thermal conductivities (k factors) for plastics given in Table V are several hundred times lower than those of metals. This low rate of heat transfer is a useful property for piping applications because it obviates a need for thermal insulation.

The high electrial resistance of plastic materials is also of practical significance. Plastic pipe is immune to electrolytic or galvanic corrosion. Resistance of plastic materials to passage of electric cur-

Creep: A Serious Problem in Plastic Pipe[19]

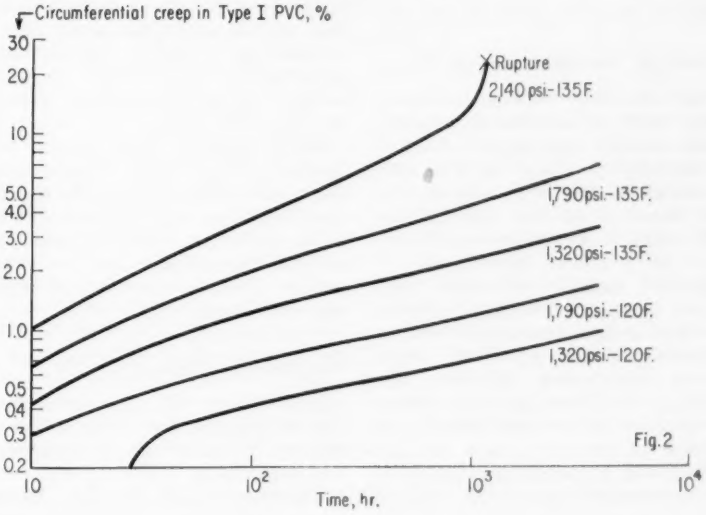


Fig. 2

rent is especially advantageous for buried piping since plastics, unlike metals, are not deteriorated by stray currents in the soil.

The nonconducting property of plastics is also taken advantage of in the construction of insulating couplings installed in buried metal pipe lines as a protection against stray current electrolysis.

Flammability: 3 Categories

Flammability of plastic materials is commonly determined by quantitative tests (ASTM, Military, SPI, Underwriters' Laboratory). These measure the burning rate in in. or sq. in./min. under specified standard conditions.

The ASTM test results listed in Table V show burning characteristics of plastic pipe materials fall into three distinct categories—nonflammable, self-extinguishing and flammable.

Phenolic asbestos and fluorocarbons do not support combustion. Saran, PVC and nylon burn only if continuously subjected to an external source of flame and are designated self-extinguishing.

Remaining thermoplastics listed can be ignited fairly readily and will continue to burn at a slow regular rate, roughly equivalent to that of medium density wood. None will burn at a rate even faintly approaching the rapid and violent combustion of cellulose nitrate.

Reinforced polyester-glass and epoxy-glass may either be self-extinguishing or slow burning. The glass acts as a fire retardant, and maintains physical integrity of the pipe.

Consider Variables Involved

As with other combustible materials used in structural applications, severity and extent of a fire is strongly governed by size and geometry of the part, temperature and duration of heat application, and wind and ventilation conditions. Also of practical significance is type and quantity of smoke produced. Large quantities of plastics involved in fires frequently produce billowing clouds of dark dense smoke, hampering effective fire control. A further hazard created by combustion of some plastics is release of noxious gases. It has been found for example, that PVC or acrylonitrile polymers liberate carbon monoxide and hydrogen chloride as well as small amounts of ammonia, cyanides, and oxides of nitrogen.[86]

Of course, flammability is only part of the picture. All plastics subjected to intense heat or open flames will decompose. Plastic structures exposed to plant fires will generally suffer damage beyond repair or salvage. In services involving transmission of flammable substances, the problem is even more acute since failure of the pipe tends to feed and spread the fire. It is understandable, therefore, that plastic pipe has found limited usage in petroleum refineries.

How to Join and Support Plastics

Thermoplastics can easily be cut, machined, threaded and joined in the field by a number of techniques. Thermosets are a little more difficult to work with. But both are easy to erect and support.

One of the most attractive features of thermoplastic pipe is the relative ease with which it lends itself to a diversity of fabricating techniques.

You can easily cut, saw, bend, thread, machine it. This makes possible quick and economic assembly, installation, maintenance and revamping of plastic piping systems with a minimum of training.

Working With Plastics

Thermoplastic pipe can be readily cut to size with an ordinary hack saw or power saw; for flexible polyethylene pipe only a sharp knife is required.

Bending of rigid thermoplastic pipe is accomplished by heating the pipe to approximately 250 F., bending it around a form, followed by quick cooling. Radius of the bend should be slightly less than the desired radius to compensate for a certain amount of springback. Flattening during bending can be prevented by filling the pipe with sand.

Rigid plastic pipe may be threaded without lubricants or cutting oils using standard metal thread-cutting tools and dies. With softer materials, it's advisable to insert a tapered plug into the pipe end to prevent distortion and produce uniform threads.

Thermosets More Difficult

Fabrication of thermosetting pipe is a good deal more difficult and limited than with thermoplastics (see Table VII).

Thermosets are harder, more rigid and obviously non-softenable by heat. Usual glass-reinforced materials are even more limited for field fabrication because cutting through or into the reinforcing cage generally weakens the pipe. Development work on this problem is going on.

How to Join Pipe

Plastic piping can be joined by a variety of methods some of which require more technique than others. The more important methods used commercially are enumerated below, with brief descriptions on their range and ease of application, and individual advantages and shortcomings (see also Table VII).

Insert fittings with hose clamps (bands or wires) are by far the most extensively used joints for standard polythylene pipe.

Since this method is applicable only to soft, flexible pipe, application is limited almost exclusively to low-density polyethylene, although some users report satisfactory results with the stiffer and harder linear type polyethylene.

Insert fittings such as couplings, elbows, tees, reducers and adapters are produced in a variety of materials, including high-impact styrene ABS, nylon, electroplated steel, copper and brass.

Majority of hose clamps used today are made entirely of stainless steel, since most failures of polyethylene on record can be traced to corrosion of clamps.

Joining lengths of flexible polyethylene pipe with insert fittings is a simple procedure requiring nothing more than a screwdriver. A

Some Common Methods for Joining and Fabricating Plastic Pipe—Table VII

	Insert Fittings (Clamped)	Threaded Fittings	Solvent Welded Socket Fittings	Thermal Welding	Flanged Fittings (a)	Adhesive (Cemented) Joints	Grooved Joints	Cutting or Sawing	Field Threading	Field Bending
Polyethylene	Yes	Yes (b)	No	Yes	Yes (b)	No	Yes (c)	Yes	Yes (b)	Yes
ABS polymer	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
PVC (Type I)	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
PVC (Type II)	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Butyrate (CAB)	No	Yes (d)	Yes	No	Yes	No	Yes	Yes	Yes (d)	Yes
Vinylidene chloride (saran)	No	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Phenolic asbestos	No	Yes	No	No	Yes	No	(e)	Yes (f)	Yes (f)	No
Polyester-glass	No	Yes	No	No	Yes	Yes	(g)	No	No	No
Epoxy-glass	No	Yes	No	No	Yes	Yes	(g)	No (h)	No (h)	No

(a) Flanges are frequently metallic.
(b) Threaded and flanged joints not generally used with low density, flexible polyethylene.
(c) Only with heavy wall high-density polyethylene.
(d) Threading not recommended.
(e) Under development.
(f) Carbide tool required.
(g) Fiberglass reinforced pipe should not be grooved by standard groove cutting tools. Victaulic couplings can be used by anchoring to a collar attached to outside of pipe.
(h) Fibercast Co. claim that their pipe can be cut without damaging using proper technique; also that field threading for receiving cemented flanges is permissible.

hose clamp is slipped over each of the pipe ends and a coupling is then hand-forced into the two ends. Worm-drive screws are tightened with sufficient pressure to cause the serrated ends of the coupling to bite into the I. D. of the pipe. For sizes upward of about 1½ in., two pipe clamps per shank (four per coupling) are sometimes used to insure proper closure.

Screwed Connections Are Weak

Screwed joints, the oldest and most conventional manner of connecting lengths of plastic pipe find application principally in the heavier wall schedules of thermoplastic pipe. Advantage of easy disassembly offered by screwed joints is more than offset by impairment of strength properties resulting from the threaded ends.

In addition to the decrease of load-bearing ability at the reduced cross-section, the V-notch at the end of the thread on the O. D. of the pipe creates an area of stress concentration which can serve as a point of impact failure. To minimize mechanical failure, the industry recommends threaded connections should be used only with Sch. 80 or Sch. 120 pipe. As a further precaution, it is recommended that pipe be threaded at least ⅛-in. shorter than the seat of the coupling to insure complete coverage of the threaded portion of the pipe.

In contrast to thermoplastics, screwed connections are a standard joining method for thermosetting pipe. Major brands of glass-reinforced polyester and epoxy pipe are commonly furnished with threaded ends, molded integrally on the pipe. Standard thread cutting techniques are not permissible—this would cut into the glass cage.

Disadvantages of screwed connections don't apply in this case, since molded threads don't have sharp corners and there is no decrease in wall thickness.

In assembling threaded pipe and fittings, strap wrenches should be used in place of ordinary pipe wrenches. Steel jaws tend to deform and scar the pipe and standard pipe wrenches may apply excessive torque stripping the threads.

To avoid binding action in joining and to facilitate uncoupling, a nonsolvent plastic pipe compound is recommended for threaded assemblies. Standard thread compound can be used, but for extreme chemically resistant applications, a compound based on tetrafluoroethylene resins is preferred.

Solvent Welding Widely Used

Since the creation of S. W. P. pipe sizes, solvent-welded socket or slip-sleeve joints are widely used. Types of thermoplastics which lend themselves to this method are polyvinyl chloride, ABS and butyrate.

In general, each type of material requires a particular solvent* (usually ketonic), but special solvent compositions are available for making dissimilar welds between various thermoplastics.

Solvent welding is now the preferred method for joining rigid and semi-rigid thermoplastic pipe. It gives a stronger and surer joint than threading and is consider-

* Solvents are often called solvent cements, but they are not true cements. We will define cement here as a putty-type adhesive.

ably faster and simpler. As an added attractive feature, it permits use of thinner thicknesses compared to screwed pipe for equivalent pressure ratings.

Mechanical excellence and ruggedness of solvent welded socket joints was recently demonstrated in a laboratory study.[29] Schedule 80 PVC pipe assemblies, containing solvent-welded couplings, were subjected to short and long-term hydrostatic pressures at room and elevated temperatures. All burst failures which occured in the course of the tests were in the pipe proper, not at the joint.

Joining pipe by solvent welding is quite simple. Pipe is cut square and all connecting surfaces are properly cleaned. Solvent is then sufficiently brushed on the I.D. of the socket fitting and the O. D. of the pipe (avoid excess solvent). The joint should be made immediately after applying the solvent and then given a half-turn to dispel air and insure even spread of the solvent. The joint must remain completely undisturbed for at least 15-30 min. after which it has set sufficiently to permit handling; full working strength is attained in about 48 hr.

Simplicity and bond strength of solvent welds offer an easy and practical means of field repair. Punctured pipe can be patched using the "half-sole" method. Longitudinal half sections of pipe (of the same diameter) are solvent brushed and clamped over the failed area. This method is not good for cracks, since they can propagate underneath the patch.

Thermal Welding More Difficult

Heat or thermal welding (sometimes called flame welding) is an acceptable method for joining polyethylene, Type I PVC and saran pipe and fittings. But it requires appreciably more technique than other methods of joining.

For successful thermal welding you need accurate control of heat input to the edges of the weld so the plastic softens sufficiently for fusion to take place. At the same time you must prevent resin deterioration due to overheating. This requires considerable skill and experience because the temperature difference between the softening point and the point where the plastic begins to char and discolor is quite small, in some instances less than 100 F.

The problem of proper temperature regulation is further complicated by poor thermal conductivity of plastics. Since overheating causes permanent damage, thermal welding is preferably performed at the lowest temperature feasible. Thus true melting occurs only at the surface.

Most of the material is in the state of a soft and limp solid of a consistency similar to hot asphalt pitch.

Absence of complete fluidity as in a conventional metal weld puddle obviously makes it more difficult to get full penetration and fusion, especially in thick sections.

The most widely used technique for thermal welding uses special hot-gas welding guns, electrically heated or acetylene fired, for furnishing a controlled source of heat.

The type of gas used depends on the variety of plastic being welded; air is commonly used for PVC, but inert gas is preferred for welding polyethylene to minimize surface oxidation. Although welds may be made by simply butting together heated pipe ends, the great majority of heat welding utilizes filler rods made of the same material as the parts to be joined.

In addition to hot-gas welding some variants of heat welding methods are used occasionally. This includes heat-tool (hot plate), friction welding and electric resistance welding.[30, 31]

Grooved Joints Are Good

Grooved joints (Victaulic, Gruvajoint) can be used for connecting pipe and fittings of rigid or semi-rigid thermoplastics. Advantage of grooved joints include ease and rapidity of uncoupling, and also their ability to take up minor amounts of contraction and expansion. This ability to "give" is particularly attractive for plastic piping systems since it may eliminate the need for costly and cumbersome expansion joints.

On the debit side, the cut groove weakens the pipe similar to threading, and lowers the allowable pressure rating. For the lighter pipe schedules, this disadvantage can be avoided by use of a recently developed method of grooving, where the groove is rolled into the pipe without removal of material.

Grooved couplings are not readily adaptable to glass-reinforced thermosetting pipe because cutting of the groove impairs the mechanical properties of the pipe. Hence, it is customary to employ a cemented-on collar in place of the groove for anchoring the joint's housing clamps. Another possibility would be to produce a molded groove which, as is claimed for molded threads, should not weaken the pipe. However, to our best knowledge, none of the varieties of thermosetting pipe currently manufactured in this country are available with standard grooved ends.

Flanging Is Still Popular

Flanging, one of the earliest and time-proved methods for joining plastic piping, continues to be extensively used, primarily for process piping.

Flanged connections are tight, strong and simple to install and disassemble.

Plastic flanges are commonly produced by molding or fabrication, and are attached to the pipe by screwing, cementing or welding. It's also possible to produce flanges integral with the pipe, either by molding or hot forming techniques.

For greater strength, steel or cast iron flanges are frequently used to connect plastic pipe. Two popular varieties are Van Stone flanges and split-type flanges. Split cast iron flanges are standard joints used for joining Haveg phenolic-asbestos and furane-asbestos as well as Spiral-Glas pipe.

Cemented Joints

Cement welding by means of an adhesive putty offers an alternate to screwed or flanged connections for glass reinforced polyester or epoxy piping.

This method is used primarily for cementing on piping components such as flanges, collars and adapters. It is, however, occasionally employed for connecting pipe lengths with specially designed couplings. Such joints are as effective as screwed connections, if properly made; however, such factors as resin-to-catalyst ratio, surface condition of the interface and ambient temperature conditions can greatly affect strength of the joint.

Wrapped joints, developed spe-

cifically for glass-reinforced pipe, present an interesting adaptation of cement welding. Technique consists of wrapping the ends to be joined with multiple layers of glass cloth saturated with thermosetting resin catalyzed for air curing. Considerable skill and time is required to make sound wrapped joints for pressure piping. This method is hardly ever used for joining pipe sections, except in low pressure furane-glass piping systems. With glass-reinforced polyester or epoxy pressure piping, wrapping is employed to best advantage for making on the spot field repairs or changes in layout.

It is interesting to note that similar techniques, originally developed for automobile body repair, have been highly successful for "in situ" patching of corroded or cracked metal parts. Steel pipe thus repaired with epoxy-glass bandages has successfully withstood continuous exposure to pressures of several hundred pounds per square inch at temperatures to 250 F.[32]

Other Types Available

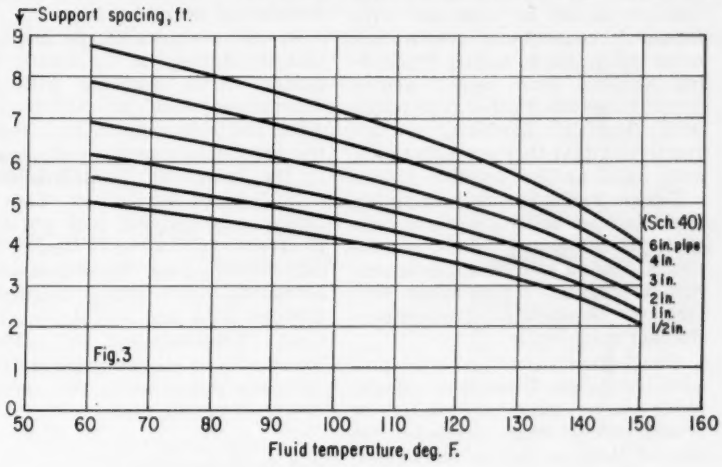
Other types of joints occasionally used to connect plastic pipe are slip joints (Dresser couplings) and a variety of specialized O-ring fittings resembling Ring-Tite (Transite) couplings. Both joints allow the pipe ends to move axially and thus accommodate for thermal expansion. O-ring joints permit up to 10-deg. misalignment. Metallic and plastic compression fittings are also used with plastics but almost exclusively for connecting small size flexible tubing. Finally, there are available a variety of specially designed adapter fittings for joining plastic pipe to metal pipe, valves or nozzles.

How to Support Pipe

Plastic pipe can be installed by burying underground, resting on supports or suspending from vertical or overhead surfaces.

In any case, proper design and installation of plastic piping systems demands recognition of the limited strength, high creep rate and thermal expansion characteristics of most plastics. These considerations are of greatest importance in dealing with thermoplastics operating at or near the upper allowable temperature limits.

Use These Support Spacings When Installing Type I PVC Pipe



Thermoplastic pipe should be supported at intervals roughly ½ to ¼ normally required for steel pipe.

Supports and hangers can be of clamp, saddle, friction or other standard variety. Support designs which provide a broad smooth bearing surface are superior to narrow or sharp-edged contacts since they minimize stress concentration, distortion and physical damage to the pipe. Vertical lines of appreciable height should also be supported, preferably by spring hangers.

Generally, supports should not be tightly clamped or attached to the pipe so as to permit axial movement. Rigid clamping is good at valves and fittings located near sharp turns in systems subjected to wide fluctuations in temperature.

Progressive softening and distortion with increasing temperature requires more frequent support spacing at higher temperature levels. This is graphically illustrated by Fig. 3 which shows recommended spacings as a function of temperature for ½ to 6 in. dia. Sch. 40 Type I PVC pipe (uninsulated, full of water).

Values plotted are representative of recommendations contained in technical bulletins of major domestic extruders and distributors. Similar plots can be devised from manufacturers' recommendations for other thicknesses and different types of plastics. Additional supports should be provided at fittings, valves and other piping components to carry extra weight and to absorb possible torque stresses created by manipulation of valves or other motive devices. Lines with external insulation or conveying heavy liquids also require added support.

Continuous Supports Favored

Continuous supports are at times employed, especially at higher temperatures where economics may favor use of continuous troughs, such as angles or channels, over closely spaced intermittent supports. Aside, however, from cost considerations, continuous supporting is mechanically superior and appears advisable and justified for high-temperature installations.

This line of reasoning is becoming more prevalent. Conservative users call for continuous cradling of all thermoplastic pipe operating within about 15-25 F. of the upper recommended temperature.

How to Handle Expansion

The problem of thermal expansion can be solved by a variety of design features depending on the geometry and the anticipated temperature fluctuations of the piping system. Thermal compensation is generally not required when the over-all temperature range is less than about 30 F., even with thermoplastics having high coefficients of expansion.

Simplest scheme for absorbing moderate thermal strain takes advantage of inherent line flexibility

at points of directional change. Caution should be exercised with threaded connections which are more vulnerable to failure by bending stresses than socket welded joints. Grooved or other type joints with "built-in" flexibility are attractive in that they are able to absorb axial and/or angular strain.

Dimensionally constrained piping systems, such as long straight runs with fixed terminal points, require special design provisions to accommodate thermal strain when subject to appreciable temperature fluctuations.

One common practice is to provide lyre loops, U-bends or offsets. With large diameter piping or where lack of space precludes the use of loops or bends, mechanical expansion joints are a practical solution for thermal expansion problems. Expansion joints fabricated of plastic are available in either bellows (Teflon) or slip-type designs; standard rubber and stainless steel expansion joints also find extensive applications in plastic piping systems.

Glass reinforced thermosets generally require little special consideration in view of their high strength and relatively low expansion coefficients.

Buried Piping Systems

Burying of plastic pipe is generally considered superior to above ground installations. It affords greater protection against physical damage and also prevents deterioration due to weathering. Elementary precautions to be followed in installing underground systems apply to both thermoplastic and thermosetting grades of pipe.

Thermal expansion and contraction is easily offset by snaking the pipe from side to side along the ditch; for thermoplastics, one additional foot per 100 ft. of pipe is a recommended minimum allowance for snaking. Snaking also serves to absorb elongation of pipe due to internal pressure stress.

In conclusion we should mention that the Society of the Plastic Industry (SPI), working with organizations such as ASTM and ASA, has been instrumental in aiding the establishment of standards by the Commodity Standards Div., U. S. Dept. of Agriculture. This includes polyethylene (CS 197-57), Butyrate (CS 206-57) and PVC (CS 207-57) pipe. These and other standards are being circulated through ASA and ASTM for adoption. Establishment of official standards by these organizations will be a milestone in the coming-of-age of plastic pipe.

Acknowledgement

The author wishes to express his appreciation to Mr. R. M. Levy (Materials Development Laboratory, Esso Research and Engineering Co.) and Dr. F. W. Reinhart (Chief, Plastics Section, National Bureau of Standards) for reviewing this paper. Also gratefully acknowledge the cooperation of the SPI and other technical and trade societies, as well as the many companies too numerous to mention who supplied valuable information.

G. SORELL, *is a materials and corrosion engineer with the M. W. Kellogg Co., New York. His duties include specifying materials and corrosion protection for a large variety of chemical and petroleum process plants. Born in Vienna, he came to this country in* 1939 *and served with the U. S. Army in World War II. Mr. Sorell has both BS and MS in chemical engineering from Princeton. He is a member of NACE, the Scientific Research Society of America, Sigma Xi and Phi Beta Kappa.*

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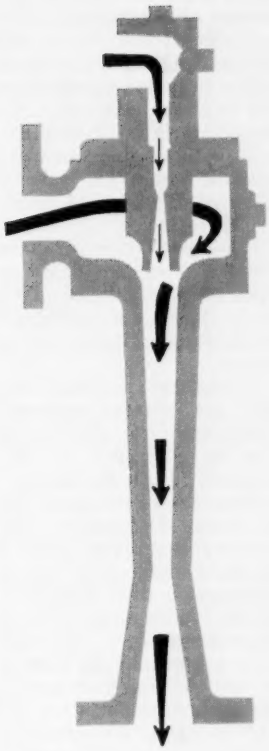
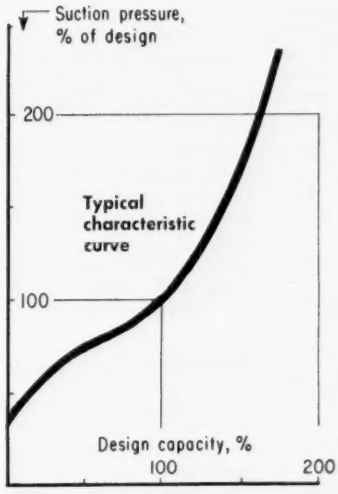
Five Ways to . . .

Automatically Control Pressure

For Ejector Vacuum Systems



GRAHAM B. KNIGHT,
J. R. Minevitch & Associates,
Boston, Mass.



STEAM jet ejectors, as has often been pointed out,[1-4] are useful pumps for vacuum systems. Pressure control of the systems of which they are a part, although essential to satisfactory operation in many cases, has received less attention. It is our purpose in this article to present various pressure control schemes for ejector systems. The examples do not exhaust all possible methods of control. Instead, they are typical applications of control design principles.

Three principles govern the control of steam jet ejectors:

- Each ejector in a system operates along a fixed curve of suction pressure versus capacity for .. given discharge pressure (see curve).
- Each ejector has a fixed minimum suction pressure for a given discharge pressure, below which the jet will "break," i.e., a pressure at which vapor flow in the diffuser will be reversed. Operation below the break pressure is unstable, but as suction pressure increases above the break pressure, a "pickup" pressure is attained at which stable operation returns, with normal flow in the diffuser.
- Each ejector has a maximum discharge pressure for a given load, above which the jet will break. A pickup pressure somewhat below this will restore stable flow.

Of course it is important in any ejector system—whether controlled or not—to design for stable operation. But when writing specifications for a controlled ejector system, these principles are basic. The stable range must be sufficient for the control function to be exercised at all anticipated conditions of suction pressure and capacity.

Systems Without Intercondensers

Let us first consider the single-stage ejector unit. A single unit is often used to produce minimum pressure of 100 mm. Hg abs. in continuous-duty application, or a somewhat lower pressure in intermittent service. A single ejector system often can be controlled as in scheme 1, page 172. The ejector system is loaded to the required point on the capacity-suction pressure curve by bleeding atmospheric air, or other gas or vapor, into the suction side of the ejector. The only provision required in the ejector specification is an allowance of additional capacity over the expected maximum load from the unit.

The simplicity of control for this system cuts hardware cost. The control valve is small in comparison with valves for other methods. It is often practicable to size the valve to handle full ejector capacity at the highest anticipated operating pressure. Shown in scheme 1, a globe valve in series with the control valve may be used to assure good control. This manual valve, in addition to making close control of the pressure drop across the control valve possible, allows the system to be run on hand control for brief periods.

There are several other advantages to this system. The control

valve is subject to atmospheric corrosion only. It requires no bypass because of the manual globe valve. And since there are no valves on the vacuum line, it is often unnecessary to provide a pressure-relief device on the process side. Normally, though, it is good practice to include a block valve in the line to test vacuum. This valve can be "car-sealed" or locked open in normal operation.

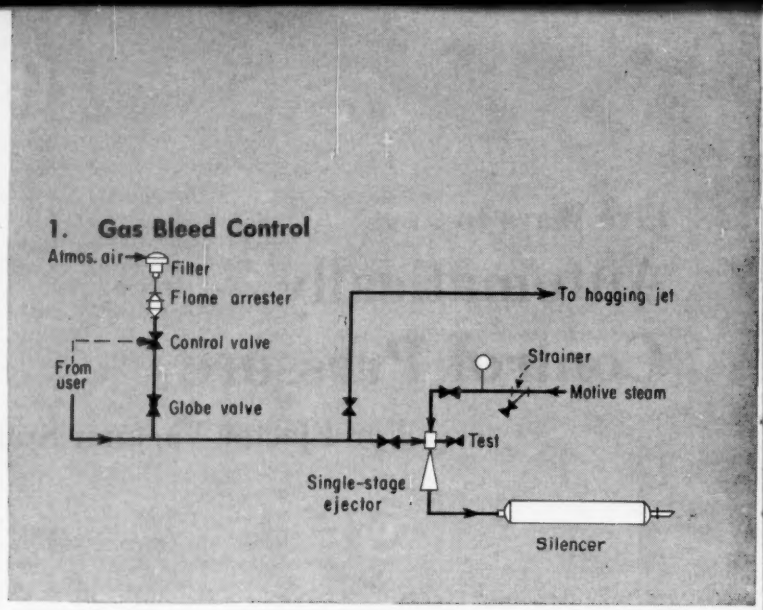
The installation of scheme 1 shows a filter and flame arrester. These need be installed only in cases where there is a problem of control-valve plugging or an explosion hazard.

Multistage non-intercondensing units act in many respects like a single-stage unit, and in many cases may be controlled by the same methods. Such multistage ejector systems can be designed for almost any required condition, but steam economy is usually lower than if intercondensers were included. The compression ratio attainable is, of course, much higher than with single-stage units, but multistage units are principally used in intermittent service. They are also used where corrosion or other undesired factors of intercondensing units might economically outweigh the greater steam use of the non-intercondensing unit.

Just as the plan of scheme 1 might apply also to multistage units, so does the plan of scheme 2 apply to single-unit control. In this second method, a throttling valve varies the steam ejector suction pressure, rather than the load. As indicated in the diagram, this system can serve several independently variable process "users." On the other hand, ejector design must allow for a control-valve pressure drop of usually 5 to 10 mm. Hg—a limitation that doesn't recommend use of the system for controlled pressure of less than 20 to 30 mm. Hg abs. because of the increased ejector size and steam consumption. of this plan.

Control-valve size, in this scheme, will normally be that of the line, or perhaps one size smaller. It must, of course, handle the full air and vapor load to the ejectors. A manually operated bleeder valve on the load side of the ejector permits operation away from the "break" point at low user load. It permits adjustment of the suction pressure to a point where the control valves are favorably positioned for close control.

Since there are valves in the vacuum suction line, it is necessary in some cases to provide an overpressure relief device for the system. It may also be advisable to provide block and bypass valves to remove the control valve from service for maintenance.



Multistage Intercondensing

Two-stage intercondensing units are used for suction pressures down to about 10 mm. Hg abs.; three-stage to about 3 mm. Hg abs. Intercondensers change the operating characteristics of a multistage system. The ejectors operate as a series of individual compression stages rather than the system acting as a single unit. In design, it is necessary to respect the limits of maximum discharge pressure and minimum suction pressure for each stage. Otherwise the system will not operate stably. The control problem requires that one or more stages be loaded so that no ejector must work at or near the operating limits.

The pressure drop required for throttling control, scheme 2, is bought at the cost of larger equipment and greater steam consumption. For system pressures of less than 30 mm. Hg abs., this cost usually becomes prohibitive. The control plans in schemes 3 and 4 show possible alternative arrangements for these lower pressures.

In the two-stage system of Fig. 3, the ejector system is loaded by recycling atmospheric-stage exhaust to the suction side of the low-pressure stage. This method is usually suitable for ejector systems designed primarily to handle non-condensibles.

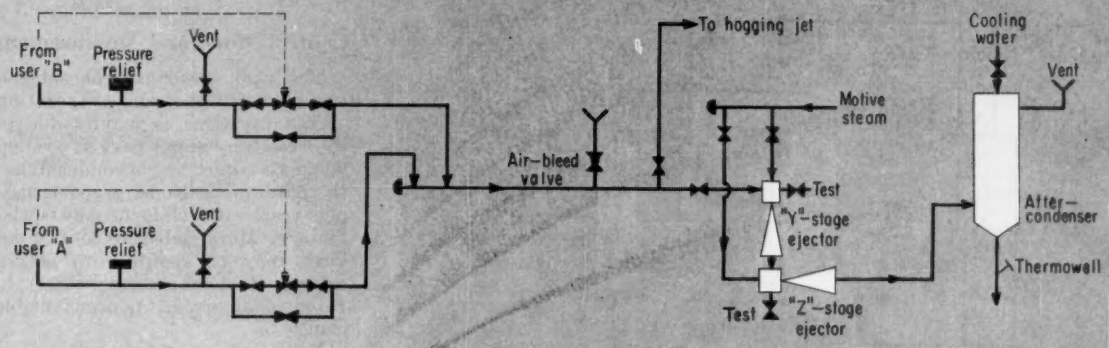
In systems in which substantial quantities of vapors condense in the intercondenser, the quantity of vapor required to load the low-pressure-stage ejector can exceed the quantity of vapor in the atmospheric-stage exhaust. The result is that air can be pulled into the system. The air will pass through the intercondenser and tend to overload the atmospheric stage. This raises the atmospheric-stage suction pressure, which is the discharge pressure of the low-pressure-stage, to the point where the low stage becomes unstable.

This problem can be solved by using steam as the loading medium, either alone or in combination with the recycled exhaust. The latter plan is used in scheme 4. The pressure controller operates split-range control valves in such a way that steam is introduced into the suction line only after the maximum amount of exhaust is being recycled.

Four-Stage Intercondensing Units

Four-stage units are used for system pressure of from 3 mm. to 0.5 mm. Hg abs. Two factors complicate the control of system pressure at these levels; the difficulty of securing reliable pressure measurement, and a system self-regulating tendency. This latter factor arises because of the rapid change

2. Throttling Control



of specific volume of the vapors compressed as the system pressure varies.

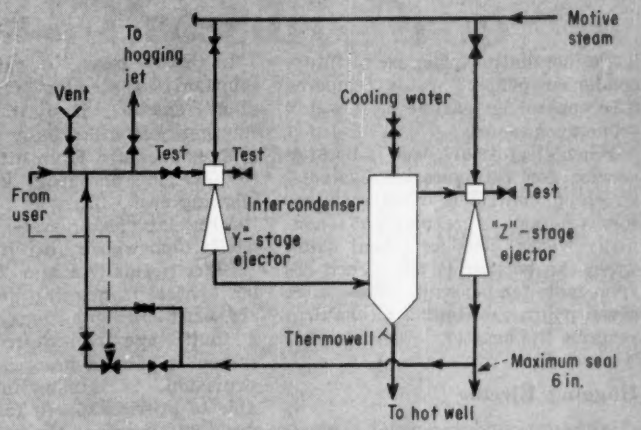
When accurate pressure control is essential, a low-pressure-stage loading arrangement, shown in scheme 5, can be used. Recycled low-stage exhaust, as used here, or injected steam can provide the loading. With exhaust recycle, control-valve size must be carefully selected because of the low available pressure drop.

Other Means of Control

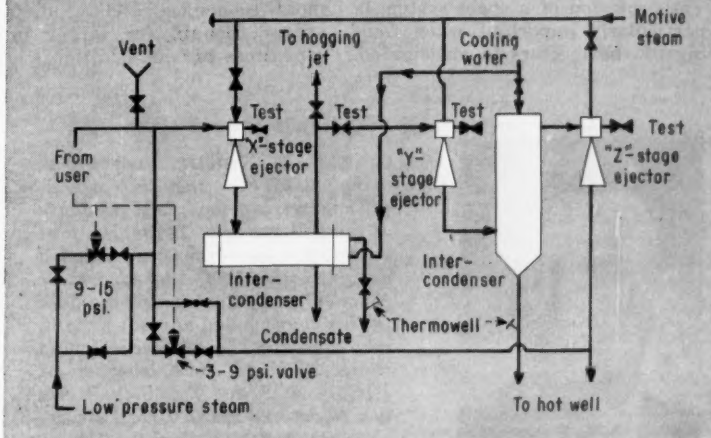
Regulation of motive-steam pressure is not generally recommended as a means of system pressure control, because reduction of motive-steam pressure to less than design value will cause unstable operation in most jet-ejector systems. In practice, motive-steam pressure should be held at or slightly above the design value. An uncommon process application provides an exception to the general recommendation. It is possible to obtain some control by throttling motive-steam power to ejectors when absolute suction pressure is more than 50% of the absolute discharge pressure.

It is possible to control system pressure by throttling condenser water, but this is effective only within narrow operating limits. Decreasing the water flow increases the intercondenser pressure by loading the succeeding ejector stage with greater quantities of water vapor than normal. However, if interstage pressure goes much above the design value, the lower-pressure ejector will become unstable. On

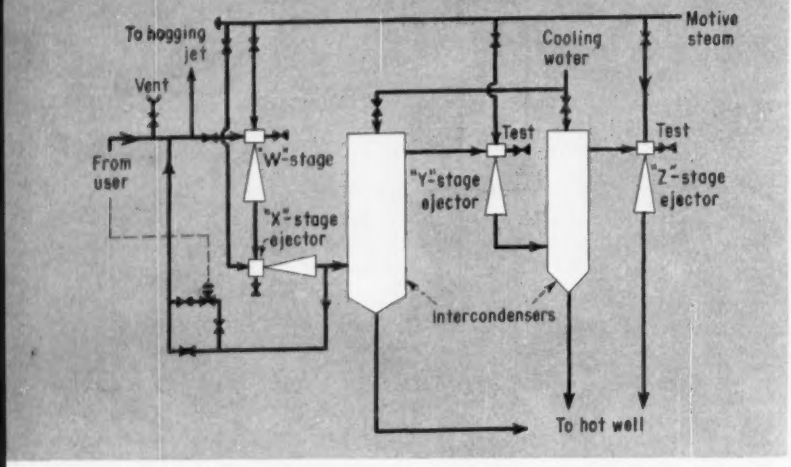
3. Exhaust Recycle Control



4. Split-Range Control



5. Control of 4-Stage Ejector System



large installations, the use of intercondenser effluent water temperature control is feasible as a water economy measure.

When ejectors are used in booster service for refrigeration systems, an on-off control is often satisfactory. A pool of refrigerant (normally water) acts as a heat sump when the booster is off. When refrigerant temperature rises to a given point, the control mechanism restarts the booster.

Hogging Ejector

Although under normal circumstances ejectors are dependable and require little maintenance, consideration must be given to the likelihood of ejector malfunction. The provision of a spare system is particularly important when fouling of the ejectors is anticipated.

In many cases, a satisfactory solution to a standby is the "hogging" ejector. Design it so in emergency it will rapidly pull down system pressure from atmospheric to near the operating level. The hogging unit ill act as a spare for the regular ejector system at a capacity somewhere near it.

Since normally steam economy is not critical in hogging units (they are used only for short periods), a multistage non-intercondensing system is often a practical standby provision. It is sometimes desirable to provide spares for each individual ejector of the regular system, but the expense of valving both inlet and exhaust of the regular ejector to permit its removal often makes a complete spare system more economical. The individual spares though, for larger units, sometimes provide additional benefits of operating flexibility and steam economy.

Control Mode and Measurement

The rapid response characteristics of distillation and evaporation vacuum systems is mainly due to the relatively small part of system volume occupied by noncondensibles. In these applications, proportional-plus-reset control is usually satisfactory. More elaborate control devices may be required to obtain close control of system subject to rapid changes in noncondensible load.

For measurement, it is usual to locate the static pressure tap for the absolute pressure controller where the pressure has process significance (such as at the top of a distillation tower) rather than in the vent line to the ejectors. It is often necessary with this arrangement to purge the static pressure line with dry air or inert gas to prevent process materials from entering the measuring element and line during shutdown or vacuum upset.

The control systems we have discussed are quite flexible and will provide workable and economical designs for many process units. It should be remembered though that vacuum equipment seldom operates at design conditions. Predictions of air leakage rates are inexact, and in service the leakage rate frequently depends on standards of plant maintenance.

Since the penalty of undersizing ejectors may be inoperability of the system, the cautious approach is often wise. Additional capital cost and operating expense of somewhat oversize ejectors can often be justified by the saving in startup time and maintenance required to reduce leakage. On large-capacity systems, it is advisable to get the help of the ejector manufacturer in determining the best method of control consistent with flexibility, steam economy, and low first cost.

The author would like to express his appreciation to his colleagues and Croll-Reynolds Co., Inc., for helpful suggestions and comments.

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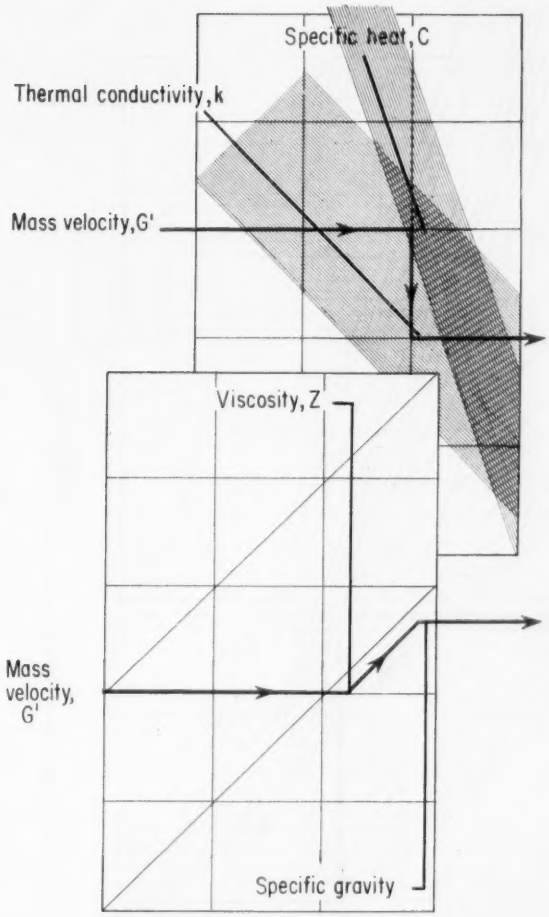
GRAHAM B. KNIGHT, *presently a principal of his consulting chemical engineering firm, is a graduate of the University of Texas. His professional experience has included design, estimating, and startup of chemical and petroleum plants both in this country and abroad. Knight, who served in the Air Force during World War II, is a member of AIChE, ACS, and Tau Beta Pi. He is a registered PE in Texas, Massachusetts, and New York.*



Heat Transfer Coefficient . . .

Pressure Drop

. . . for gases and viscous liquids in longitudinal fin shell and tube heat exchangers.

NING HSING CHEN, Heat Transfer Div., M. W. Kellogg Co., Jersey City, N. J.

ALTHOUGH heat transfer rates for extended surfaces are smaller than those for bare tubes, extended surfaces provide more surface area than bare tubes. Hence, longitudinal fins are most commonly employed in heating or cooling of gases or viscous liquids.

Experimental data for heat transfer and pressure drop in a double pipe fin-tube unit were reported by DeLorenzo and Anderson.[1] These data were correlated and recommended for the design of shell and tube fin-tube unit by Devore and Heinz.[2] Their correlation equation is:

$$\frac{h_f D_e'}{k} = 78.0\left[\left(\frac{D_e' G'}{Z}\right)\left(\frac{C Z}{k}\right)\left(\frac{D_e'}{L_e}\right)\right]^{1/3}\left(\frac{Z}{Z_w}\right)^{0.14} \quad (1)$$

We can simplify Eq. (1) to the following forms:

$$\left(\frac{Z}{Z_w}\right)^{-0.14} h_f = \frac{78.0\,(G')^{1/3}\,C^{1/3}\,k^{2/3}}{(D_e')^{1/3}\,L_e^{1/3}} \quad (2)$$

$$\phi_s\, h_f = 78.0\left[\frac{G'\,C\,k^2}{D_e'\,L_e}\right]^{1/3} \quad (3)$$

We use Eq. (3) to make Figs. 1 and 2. Note that Eq. (3) is valid only for Reynolds numbers D_eG/μ below 400.

For pressure drop calculations, Devore and Heinz correlated DeLorenzo's experimental data by substituting

$$= \frac{16}{D_eG/\mu} \quad (4)$$

into the following equation:

$$f = \frac{gD_e\,\Delta P}{2\rho\,V^2 L_e}\left(\frac{\mu}{\mu_w}\right)^{0.25} \quad (5)$$

Devore and Heinz[2] give the following simplified equation in their article:

$$\Delta P' = 6.69 \times 10^{-4}\,\frac{Z\,V\,L_e}{(D_e')^2\,(Z/Z_w)^{0.25}} \quad (6)$$

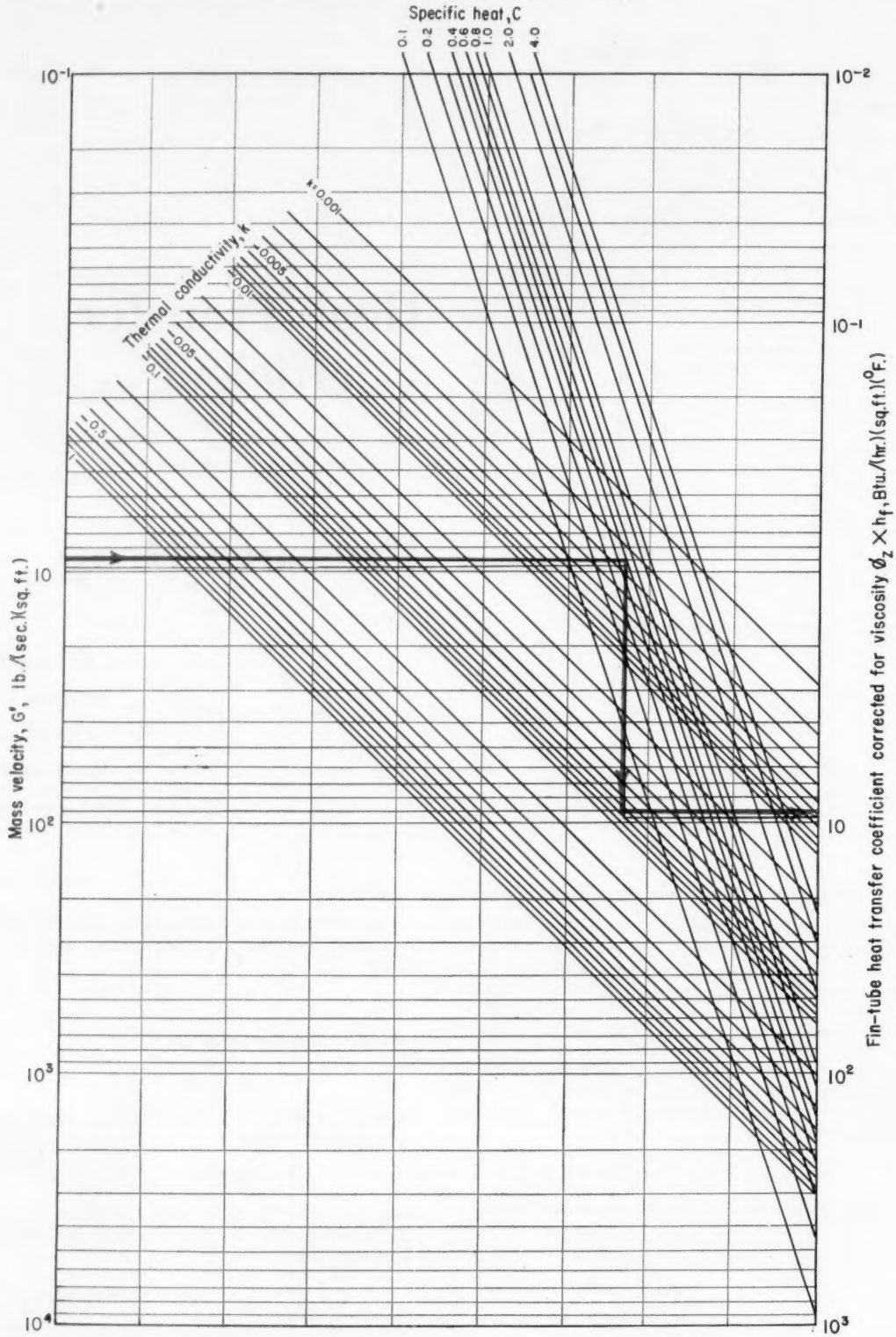
Note Eq. (6) is valid only for Reynolds numbers D_eG/μ below 400. We can rearrange Eq. (6) into the following form:

$$\left(\frac{Z}{Z_w}\right)^{0.25}\frac{\Delta P'}{L_e} = 1.07 \times 10^{-6}\,\frac{Z\,G'}{(D_e')^2\,(S.G.)} \quad (7)$$

We use Eq. (7) to construct Figs. 3 and 4.

(*Continue on page* 178)

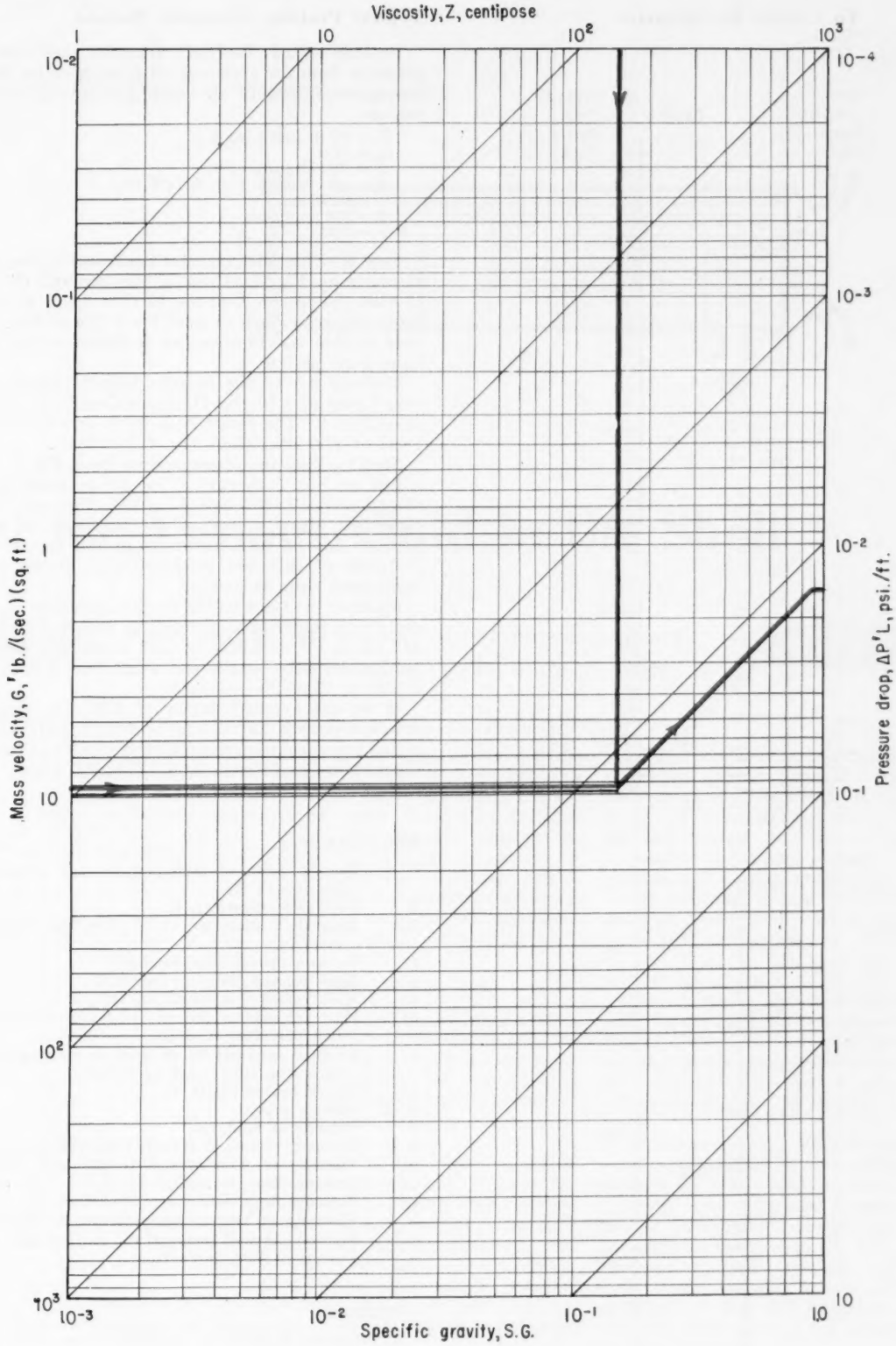
Find Heat Transfer Coefficient for Longitudinal-Fin Tubes—Fig. 1



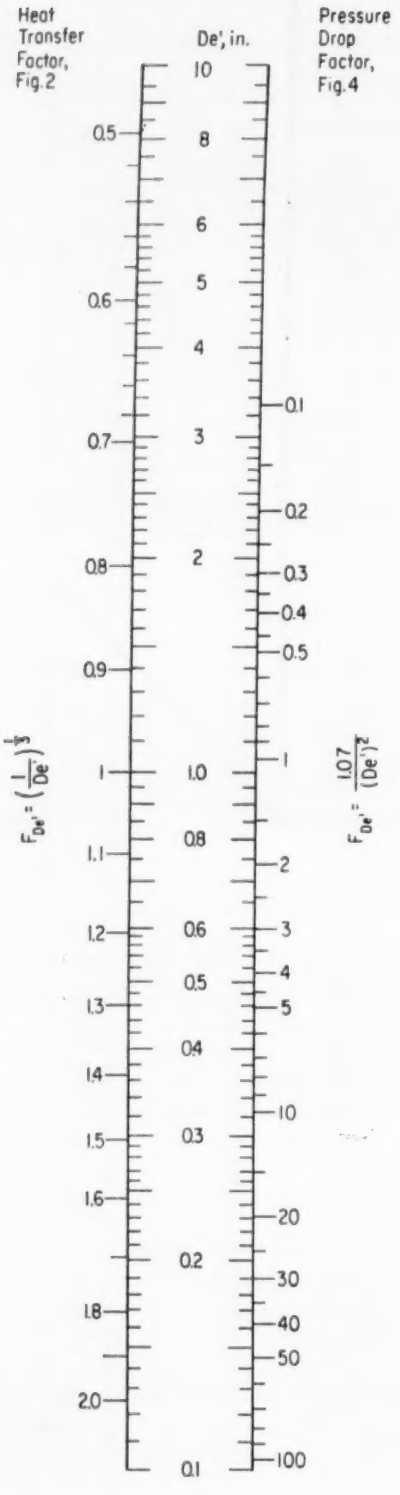
Correction Factors for Fin Tube Heated Length

Heated length, L_e	20	18	16	14	12	10	8
Factor, F_{Le}	0.928	0.962	1.000	1.045	1.108	1.170	1.260

Chart Gives Pressure Drop per Unit Length for Longitudinal-Fin Tubes—Fig. 3



To Correct for Diameter



Typical Problem Illustrates Method

Problem—Find the heat transfer coefficient and pressure drop for a viscous oil flowing under the following conditions in an exchanger having two tube passes:

G' = 9.6 lb./(sec.) (sq. ft.)
L_e = 12 ft.
C = 0.45 Btu./(lb.) (°F.).
k = 0.08 Btu./(hr.) (sq. ft.) (°F./ft.).
D_e' = 0.875 in.
Z = 150 centipoise.
$S.G.$ = 0.92

Step 1—Find heat transfer coefficient corrected for viscosity on Fig. 1. Draw a line through $G' = 9.6$ to meet the specific heat line of $C = 0.45$. From this intersection go down to meet the k line at 0.08. Ordinate of this last intersection is shown on the right-hand scale as 9.6.

Multiply 9.6 by the fin-tube heated length correction factor of 1.10 and D_e' correction factor of 1.045 from Fig. 2. The result is $\phi_e \times h_f = 9.6 \times 1.10 \times 1.045 = 11.0$ Btu./(hr.) (sq. ft.) (°F.).

Step 2—Find the pressure drop from Fig. 3. Draw a line on Fig. 3 through $G' = 9.6$ to meet the line drawn vertically through $Z = 150$. Through this intersection, draw a line at 45° to meet the specific gravity line of 0.92 drawn from the bottom scale. Ordinate of this last intersection is shown on the right-hand scale as 0.0153.

Multiply the value 0.0153 by the equivalent diameter correction factor of 1.45 found in Fig. 4. Therefore, $\Delta P' \ (Z/Z_w)^{0.25} = 0.0153 \times 1.45 = 0.0221$. Next correcting for tube length and number of passes gives $0.0221 \times 12 \times 2 = 0.53$ psi.

If we use a safety factor of 1.25, the isothermal pressure drop is $\Delta P' = 0.53 \times 1.25 = 0.66$ psi. For actual pressure drop, correct for viscosity at tube wall temperature as follows: $0.66/(Z/Z_w)^{0.25}$, psi.

Nomenclature

C	Specific heat of fluid at average temperature, Btu./(lb.) (°F.).
D_e	Equivalent diameter, ft.
D_e'	Equivalent diameter (4 × free-flow area/perimeter), in.
f	Friction factor, dimensionless.
G	Mass velocity, lb./(hr.) (sq. ft.).
G'	Mass velocity, lb./(sec.) (sq. ft.).
h_f	Heat transfer coefficient for longitudinal fin-tube, Btu./(hr.) (sq. ft.) (°F.).
k	Thermal conductivity of fluid at average temperature, Btu./(hr.) (sq. ft.) (°F./ft.).
L_e	Finned heated length, ft.
$S.G.$	Specific gravity.
V	Velocity of fluid, fps.
Z	Viscosity of fluid at average temperature, centipoise.
Z_w	Viscosity of fluid at wall temperature, centipoise.
ΔP	Pressure drop, lb./sq. ft.
$\Delta P'$	Pressure drop, psi.
μ	Viscosity at average temperature, lb./(hr.) (ft.).
μ_w	Viscosity at wall temperature, lb./(hr.) (ft.).
ρ	Density of fluid, lb./cu. ft.

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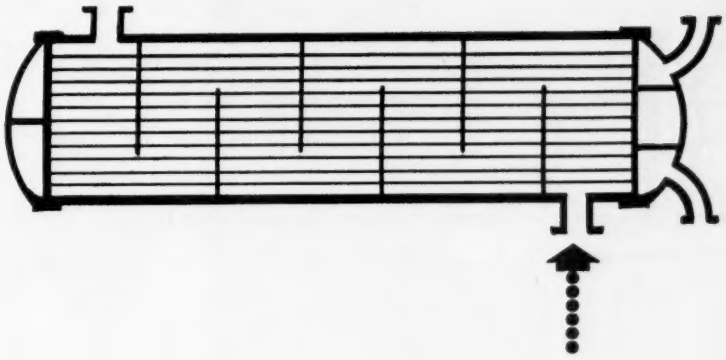
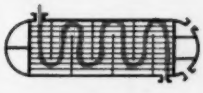


Put the Viscous Fluid in the Shell

Usual method saves in cost of equipment, however, this method can be more profitable . . .



C. J. DOBRATZ, Research Dept., Western Div., Dow Chemical Co., Pittsburg, Calif.*

In the more common case of turbulent heat transfer, the optimum size of a shell-and-tube heat exchanger (baffled shell, multipass flow in the tubes) is relatively unaffected by your choice of which fluid goes in the shell and which goes in the tubes.

This choice is usually based on factors not directly related to heat transfer, such as ease of cleaning, desirable holdup in the exchanger, etc. For example, in heat exchangers built of high-priced alloys the corrosive fluid is normally put in the tubes, since this gives the lower cost for exchangers of equal transfer surface.

However, if one of the fluids is very viscous and it also provides the controlling resistance to heat transfer, then the much better coefficients obtained for crossflow at low N_{Re} will usually overbalance all other considerations. For these cases the viscous fluid should go in the baffled shell.

Apparently the advantages of shellside heat transfer have not received proper emphasis in the past because the viscous fluid has usually been put in the shell for some reason other than heat transfer control. For example, probably the largest number of applications of viscous-flow heat exchange are in the handling of petroleum products, where the usual flow arrangements have the viscous fluid in the shell.

Let's Reverse This One

We have become aware of a widespread example wherein the viscous fluid is usually put in the heat-exchanger tubes, but really should be in the shell. This is in nickel coolers used for 50%-NaOH solutions.

Because of the corrosive action of the caustic, nickel is used for all parts in contact with caustic; and in line with normal design procedure for alloy exchangers, the caustic is usually assigned tubeside flow. However, an almost twofold saving in exchanger cost could be realized by putting the caustic in the shell.

"Prove it," you may say. Well, there's no simple analytical method which will directly compare the effectiveness of crossflow vs. in-tube flow. The comparison which is probably easiest to follow is the calculation of the heat transfer capabilities of a given exchanger.

For example, in our Pittsburg plant we have a number of Ni-tube, steel-shell exchangers in NaOH service. One of these exchangers has 240 tubes, ¾ in. × 12 ft., in an 18-in. dia. shell, and is arranged with four passes on the tubeside. We calculated over-all coefficients for this exchanger assuming different caustic flows and a water-side coefficient of 500 Btu./hr.-sq. ft.-°F.

To determine the effectiveness of this exchanger as a crossflow unit, we adjusted baffle spacings to give the same calculated pressure drop in the shell for a given caustic flow rate as for flow in the tubes. Then we calculated over-all coefficients, again assuming a water-side coefficient of 500 and including a correction factor of 0.6 for leakage around the baffles.[1]

Table I compares these calcula-

*To meet your author see *Chem. Eng.*, Feb. 10, 1958, p. 174.

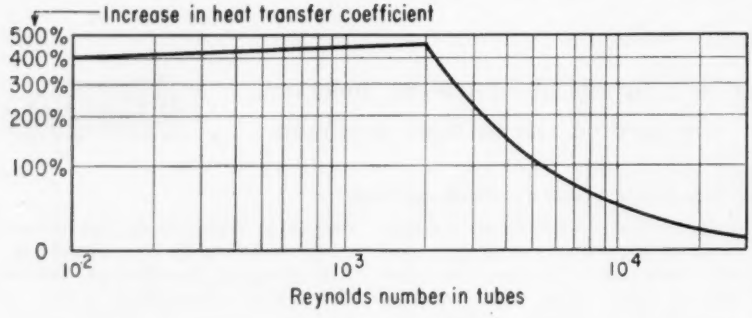
Compare Shellside and Tubeside Heat Transfer—Table I

(50% caustic soln. @ 40 C.; 240 tubes, ¾ in. × 12 ft.)

	Caustic Flow, Gpm.					
	80	120	160	200	400	600
In Tubes, 4 Passes						
Pressure drop, psi	2.7	4.1	5.5	6.8	13.6	40
Velocity, ft./sec.	1.4	2.1	2.8	3.6	7.1	10.6
Over-all U_i, Btu./(hr.) (sq.ft.) (°F.)	83	94	100	106	132	230
In Baffled Shell						
Pressure drop, psi	2.7	4.1	5.5	6.8	13.6	40
Velocity, ft./sec.	0.81	1.1	1.4	1.7	2.9	5.1
Over-all U_o, Btu./(hr.) (sq.ft.) (°F.)	175	197	213	225	264	302
Ratio, U_o/U_i	2.11	2.10	2.13	2.12	2.01	1.31

Comparative Values at Equal Pressure Drop—Table II

With Flow Inside Tubes			With Flow Across Tubes			Ratio
$(N_{Re})_i$	J_i	C_i	$(N_{Re})_o$	J_o	C_o	h_o/h_i
140	0.0123	0.14	100	0.070	0.125	5.1
300	0.0075	0.3	175	0.053	0.219	5.16
1,000	0.0033	1.0	410	0.035	0.51	5.4
2,000	0.0021	2.0	685	0.0275	0.856	5.6
3,000	0.0030	3.0	1,200	0.021	1.50	3.5
5,000	0.0038	5.0	1,950	0.0170	2.44	2.10
10,000	0.0040	10.0	3,900	0.0125	4.88	1.51
30,000	0.0034	30.0	11,500	0.0080	14.4	1.13



tions. It should be noted that the water-side coefficient, as assumed, was a significant factor in the crossflow calculations. As shown in the table, putting the caustic in the shell would give an approximate twofold advantage in heat transfer rate.

Estimated cost for two exchanger designs having an area of 565 sq. ft., as above, is $6,000 for caustic in the tubes (alloy tubes and tubesheet), and $7,200 for caustic in a baffled shell (all alloy construction). The twofold greater over-all coefficients for the heat exchanger with caustic in the shell would more than compensate for the difference in cost.

Nomenclature

D	Diameter of the tubes.
f	Friction factor.
G	Mass flow rate.
h	Heat transfer coefficient.
L	Tube length.
N	Number of tubes.
N_{Re}	Reynolds number.
U	Over-all heat transfer coefficient.
W	Total flow.
Subscripts	
e	Flow across tubes in baffled shell.
i	Flow inside tubes.

A Further Confirmation

To reaffirm our conclusions, we have made an analytical comparison of crossflow and in-tube viscous flow which is independent of the actual dimensions of the exchanger being considered.

We were forced to make a number of simplifying assumptions, but we believe that they have no serious effect on the final result. Our basis for comparison is a fixed flow, W, through an exchanger having N tubes, with the number of passes or the baffle spacings adjusted to give the same total pressure drop for both flow conditions.

Relative velocities are derived as a function of the friction factors for crossflow and in-tube flow. Thus, relative velocities for equal pressure drop can be calculated from friction factor correlations and then used to determine equivalent heat transfer coefficients.

How We Get the Coefficients

Heat transfer coefficients used in our study are based on the "J" factor correlations given in Perry's "Chemical Engineer's Handbook," 3rd Ed., pp. 468-471. The in-tube "J" factor is based on an L/D ratio of 180, which represents normal heat exchanger tube dimensions. More recent data by Bergelin, et al.,[2] show good agreement with these correlations.

We calculated pressure drops from the correlations given in Perry's Handbook on p. 390, and arrived at the following equation which simplifies the equal-pressure situation:

$$f_i\,(N_{Re})_i^3 = 0.78\,f_o\,(N_{Re})_o^3$$

This equation can be solved by trial-and-error to obtain the crossflow Reynolds number giving the same pressure drop as for flow in the tubes. These comparative values of N_{Re} for equal pressure drop are given in Table II. Also tabulated are the "J" factors for heat transfer, relative mass flows corresponding to the Reynolds numbers and the ratio of heat transfer coefficients for crossflow and flow in tubes at equal pressure drop.

As you can see from the chart given above, crossflow gives fivefold better heat transfer coefficients than flow in tubes ($L/D = 180$) at equal over-all pressure drop in the viscous flow region. This advantage drops off to equal values at Reynolds numbers greater than 30,000.

If we use the usual function of $(L/D)^{1/3}$ to express the effect of changing L/D ratio on heat transfer coefficients in tubes, then the crossflow values correspond to those which would be calculated for flow in tubes at L/D ratios of about 1 to 1.5.

REFERENCES

1. McAdams, "Heat Transmission," 2nd Ed., McGraw-Hill Book Co., Inc., New York (1942).
2. Bergelin, et al., *Trans. ASME*, 72, p. 881 (1950); and 71, p. 27 (1949).

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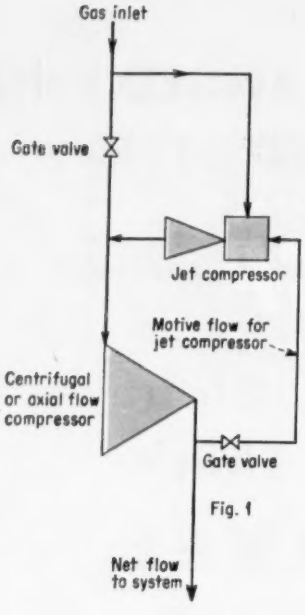

Fig. 1

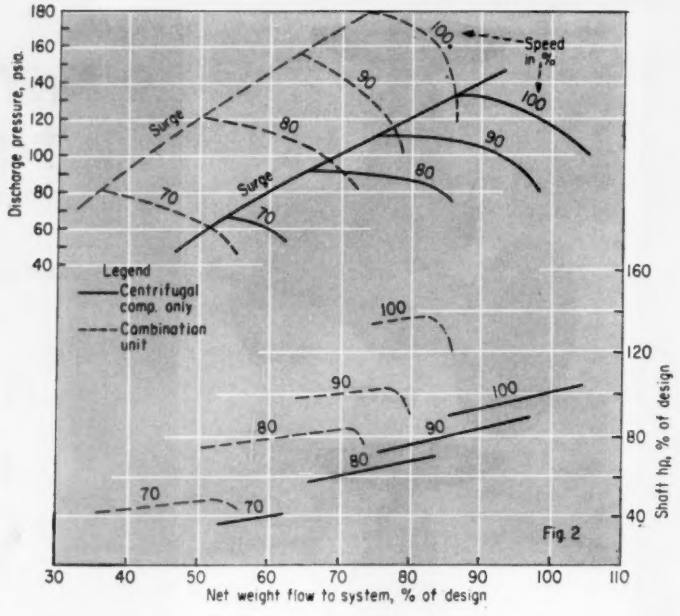

Fig. 2

Add a Jet to Raise Compressor Pressure

Although relatively inefficient, this idea is handy for temporary or occasional use of a rotating compressor above design pressure.

★ **Winner of the January Contest by**
V. V. Fondrk
Process Engineering Division, Elliott Co., Jeannette, Pa.

Rotating compressors such as the centrifugal and axial flow types are fixed-compression-ratio machines. Since they are designed for a specific compression ratio, the maximum pressure developed by the machine cannot be increased without adding additional compression equipment.

However, there is a simple way to obtain a higher discharge pressure by the use of a jet compressor in conjunction with the rotating machine. A machine designed for a 7 : 1 ratio will compress atmospheric air to 100 psia. If the inlet air is compressed by a jet to 20 psia., then the rotating machine's output will be at 140 psia.

Fig. 1 shows the arrangement. Part of the discharge flow from the rotating compressor is used as motive fluid in the jet compressor. The inlet gases are first compressed by the jet and the total mixture is then delivered to the inlet of the rotating compressor at a higher pressure level. The idea is somewhat similar in principle to a common type of deep-well pump for farm and domestic use which has a centrifugal pump on the surface, providing motive fluid (water) to an eductor at the bottom of the well. The system is valved so the jet compressor can be cut out for normal operation.

Fig. 2 shows typical results for a centrifugal compressor-jet combination. Note that the performance is for a particular design of jet compressor and that other designs can provide higher or lower discharge pressure characteristics.

This method is recommended primarily for occasional or temporary use to attain higher than design pressures. It is relatively inefficient and power usage will be higher than with a rotating machine designed for the higher pressure. Also, it must be remembered that the rotating compressor case and seals must be able to withstand the higher pressure, while extra power may be needed for compressor drive.

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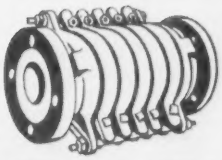

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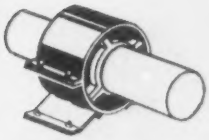

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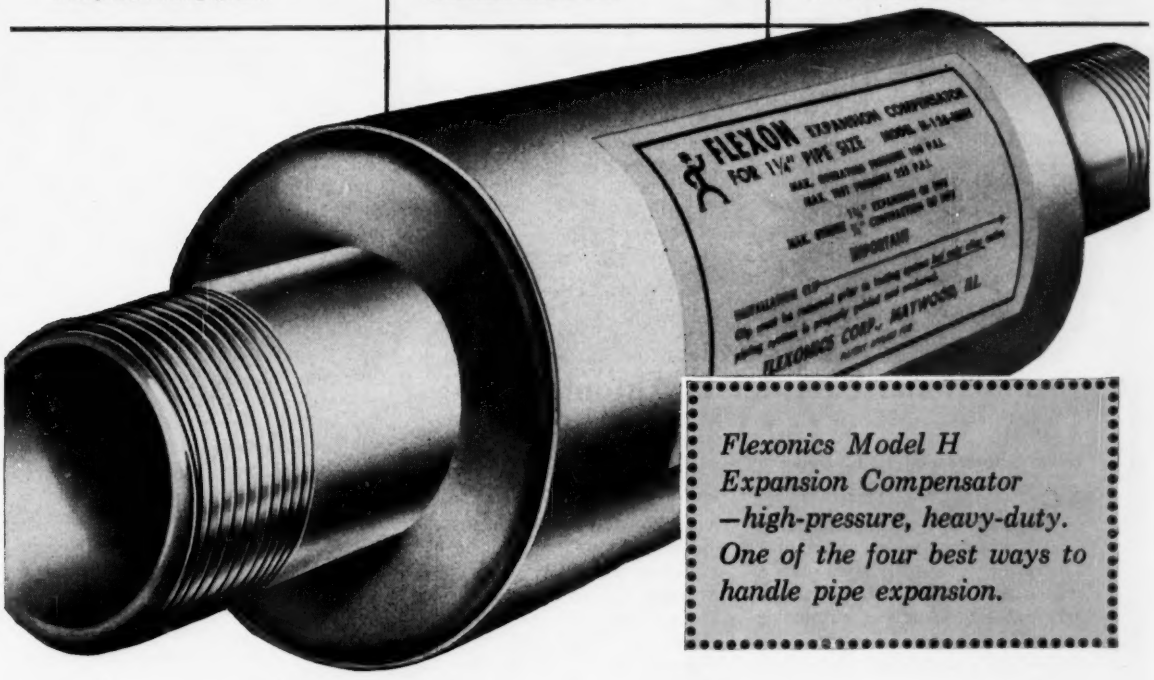

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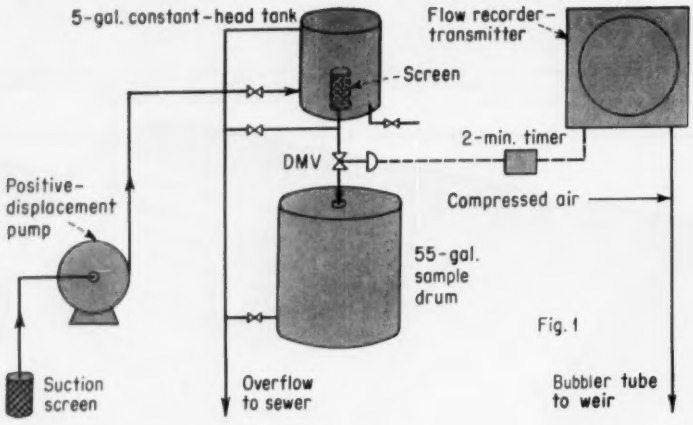


Fig. 1

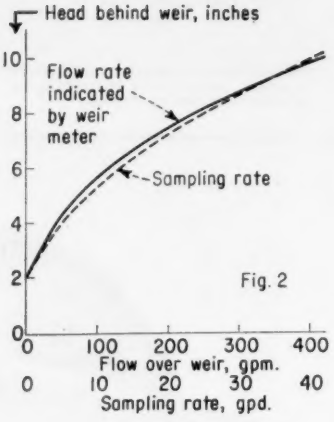


Fig. 2

Proportional Sampler Is Automatic

David Schwarz and P. C. Dolken

Process Engineers, Abbott Laboratories, North Chicago, Ill.

When the flow and composition of a liquid stream are constantly changing, it is difficult to obtain a reliable composited sample without some form of automatic proportional sampler.

Manual sampling and compositing of 24 hourly samples were unsatisfactory in our case, where we were attempting to monitor sewer streams to and from a treatment plant. Flow and composition both varied widely so increased sampling frequency could not give representative results. The answer lay in a method which would adjust sample volume automatically to the flow rate of the sampled streams.

The diagram above (Fig. 1) shows one of the systems we developed. It is paced by flow measurements obtained from a 60° V-notch weir installed in the sewer. A small positive-displacement pump is used to pump a stream of liquid from the sewer continuously to a constant-head tank which overflows back to the sewer.

The flow across the weir is metered continuously by means of a level-recording integrator and transmitter which obtains its impulse from an air-bubbler dip pipe installed upstream of the weir. The instrument transmits a signal through a timer to an air-operated diaphragm control valve located below the constant-head tank.

When the timer is actuated it transmits air pressure and opens the control valve proportional to flow rate, thus discharging a sample to the collecting tank. Adjustment of the timer varies the time the control valve is open each cycle and thus alters proportionality between main flow and sample volume.

All components of the sampler are mounted on a skid so as to be readily portable. All that is required for operation, after a weir has been installed in the stream to be measured, is a source of compressed air and 110-v. current. If these are unavailable, the unit can be modified to operate from batteries and cylinder air.

Each morning the operator stirs the contents of the collecting tank, draws the composited sample, empties the tank and changes the recorder chart for the current day's operation. The only problems encountered so far have been occasional clogging of the suction screen on the sample pump and loss of pump prime on high suction lifts. Other than cleaning the screen or repriming the pump, no additional operator attention is required.

Fig. 2 is a plot of sewer flow rate, as measured by the head behind the weir, plus a curve of sampling rate against sewer flow rate. The close coincidence of the two curves shows the excellent proportionality of sample to flow. Any suitable flow meter other than a 60° weir could have been used, provided a control valve with corresponding characteristics had been selected.

Such a sampler can be built for about $1,000, including $500 for the instrument and accessories, $75 for each of the timer and control valve, $100 for pump and motor, and $250 for installation.

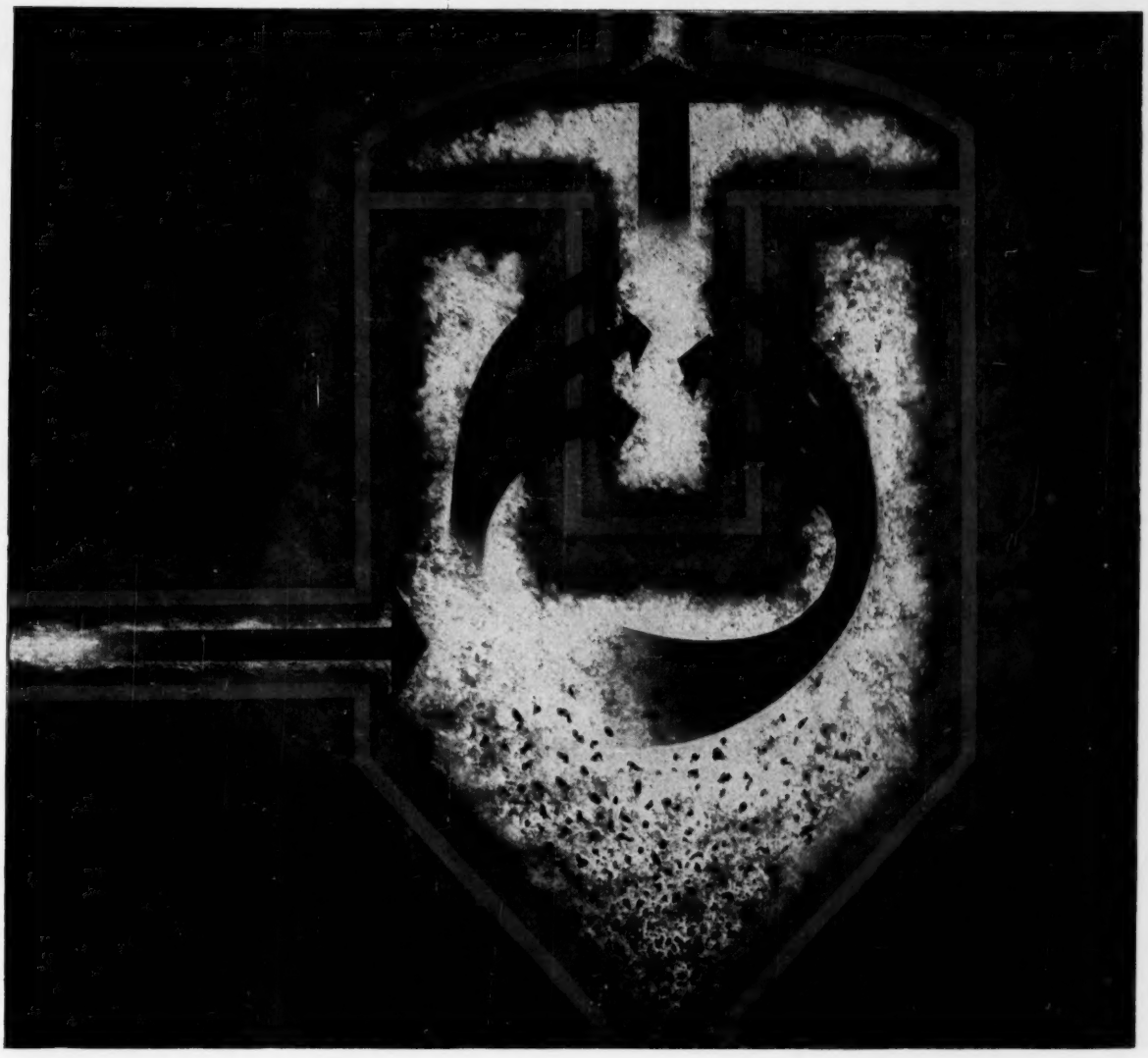
Sprayed Lining Protects Hot-Gas Exhauster

J. B. Linker

Engineer (Ret.), Akron, Colo.

Large induced draft fans used on the waste-heat boilers of cement kilns require frequent relining and reblading of the fans owing to the abrasive character of the cement dust they must handle. While managing the operation of such boilers I developed a system for protecting the fans which I used successfully for a long period, with considerable saving of money.

We discovered this scheme while using a high-temperature fireclay sprayed on with a cement gun to protect the kiln and boiler gas chambers. At this time the fans were slowed down to about 10% of normal speed and we tried spraying this high-temperature material over the blades and the case lining.



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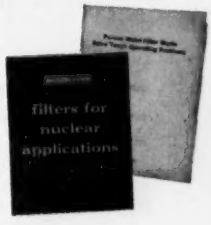

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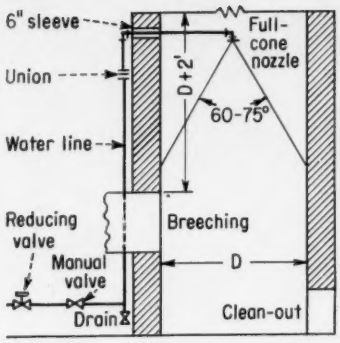
This treatment had little effect on the fan efficiency but it meant a large saving. Prior to the treatment our four fans required relining and reblading every three or four months. After treatment no relining was needed over a two-year period.



Water Spray Effective on Stack Dusts

E. C. Cross

Oak Ridge, Tenn.

Experience with both large and small stacks, with gas movement ranging from much to little, shows that a suitable spray in the stack can remove 60 to 80% of the solids in the stream.

A constant water pressure is necessary and maximum collection efficiency is attained with about 0.4 gpm./sq. ft. of stack area. Both hollow-cone and full-cone nozzles can be used. There is a slight advantage for a narrow spray angle (60-75°).

If the available water pressure is higher than about 60 psig., it is advisable to use a reducing valve in the feed line to avoid need for a high-pressure nozzle and hold uniform pressure and flow. A nozzle of suitable characteristics can easily be selected from those described in manufacturers' catalogs.

1 - Enter %'s in boxes:

Alkyd Comp. I	Styrene Comp. II	
A 40	B 20	Mixture I
C 30	D 50	Mixture II
E 35	F 30	Desired mixture

2 - Substitute %'s in the three equations:

$$\frac{(B \times E) - (A \times F)}{(B \times C) - (A \times D)} = Q_{II} \quad (1)$$

$$\frac{E - (C \times Q_{II})}{A} = Q_I \quad (2)$$

$$1 - (Q_I + Q_{II}) = Q_s \quad (3)$$

Simplify Three-Component Blending

Jerome A. Seiner

Development Engineer, Springdale Research Center, Paint Division, Pittsburgh Plate Glass Co., Springdale, Pa.

In many process industries, a common problem is the blending of three-component mixtures, having a common component such as a solvent, to produce a blend of desired composition. For example, it may be desired to blend a 40-20-40 alkyd-styrene-solvent mixture with a 30-50-20 mixture, plus additional solvent, to produce a 35-30-35 mixture.

The system described here mechanizes the necessary calculations and greatly reduces the chance for error. It requires only a few simple substitutions and can be a considerable timesaver.

In the diagram above the percentages of the various components (except for the common component, e.g., solvent) are written into the boxes. Then the letters in the boxes immediately serve as a guide for substitution of the actual quantities in the three equations at the right.

For example, to combine the 40-20-40 and 30-50-20 mixtures to produce a 35-30-35 blend, the percentages of alkyd and styrene of the two original mixtures, and the desired percentages for the final blend, are written in as shown. Subtracting in Eq. (1):

$$\frac{20 \times 35 - 40 \times 30}{20 \times 30 - 40 \times 50} = 0.357 = Q_{II}$$

From Eq. (2):

$$\frac{35 - 30 \times 0.357}{40} = 0.608 = Q_I$$

Finally, from Eq. (3):

$$1 - (0.608 + 0.357) = 0.035 = Q_s$$

Therefore, to blend 100 lb., mix 60.8 lb. of Mixture I with 35.7 lb. of Mixture II, plus 3.5 lb. of new solvent.

Next Issue: Plastic Sleeves Protect Valve Shaft

By Zenon Todorski, Winner of the February Contest

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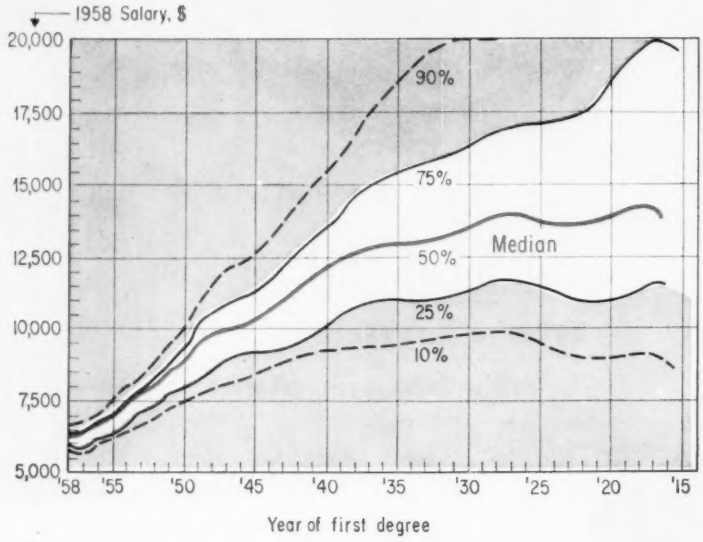
Highest	7,675	11,500	14,500	19,500	20,000+	20,000+	20,000+	20,000+	20,000+
Upper decile, 90%	6,600	7,450	9,975	12,400	14,375	17,450	19,950	20,000+	20,000+
Upper quartile, 75%	6,350	7,000	9,250	11,025	12,600	14,975	15,950	17,000	17,425
Median, 50%	**6,075**	**6,675**	**8,500**	**9,825**	**11,175**	**12,700**	**13,000**	**13,900**	**13,450**
Lower quartile, 25%	5,850	6,350	7,975	9,075	9,900	10,875	11,000	11,625	10,875
Lower decile, 10%	5,675	6,125	7,425	8,250	8,975	9,225	9,550	9,825	8,825
Lowest	5,100	5,550	5,675	6,600	5,750	5,615	5,750	5,250	5,250

This Chart Covers 12,880 Engineers Employed by the Chemical Process Industries



Are You Being Underpaid—or Overpaid?

Data on the 1958 income of 190,810 engineers have just been released by Engineers Joint Council. How does your own salary stack up against the survey?

Basically, each engineer reserves to himself the right to decide whether he is underpaid, paid enough or overpaid.

If your employer has a well-developed salary administration program, you may agree to accept the companywide decisions of the position-evaluation boys. Other engineers—almost 10% of the profession now—have partially abdicated their "right to decide" by putting their salary problems into the hands of engineering unions.

However, for those of us who must decide for ourselves, a new and extremely useful benchmark is now available. It is the Engineers Joint Council report on the "Professional Income of Engineers—1958," published early this year.*

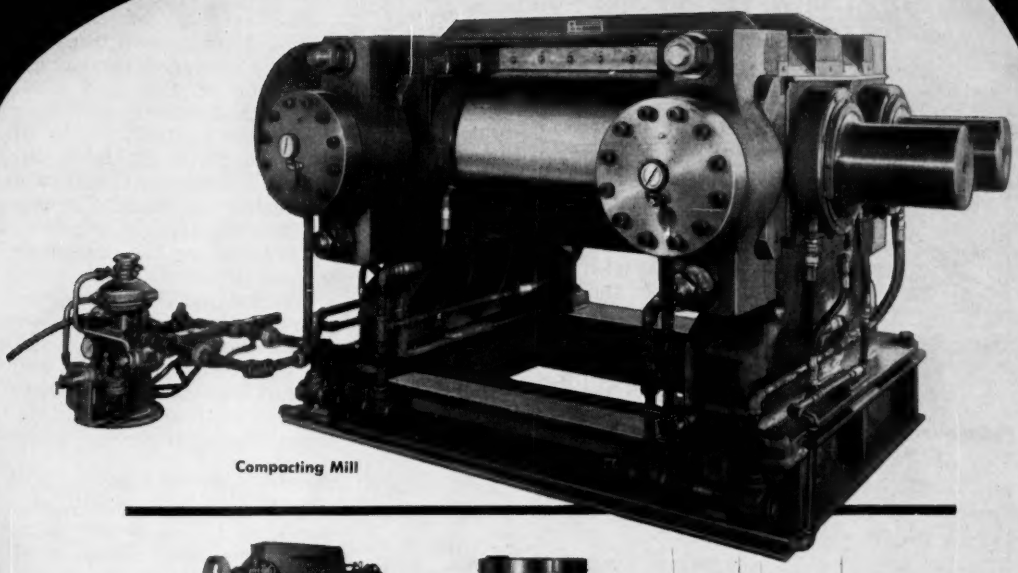
First glance-level results of the survey were released in mid-January (*Chem. Eng.*, Jan 12, 1959, p. 59). One of the most valuable aspects of the 1958 survey is that by combining it with previous surveys conducted in 1956 and 1953, we begin to get a picture of the salary progression of Mr. Joe Median Engineer from year to year. We'll have more to say about this later.

Why is this particular survey so valuable? Well, first of all it is the most comprehensive analysis of engineering earnings

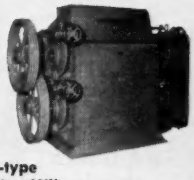
*Available from Engineers Joint Council, 29 West 39th St., New York 18, N. Y., at $3 per copy.

SCOPE in INDUSTRY
SPECIALIZATION from...

ALLIS-CHALMERS

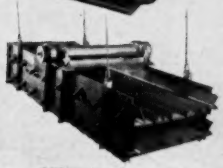


Compacting Mill



Roller-type
Granulating Mill

Gyratory Screen

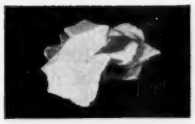


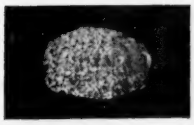
Vibrating Screen

Allis-Chalmers compacting process

Rescues "Lost" Profits

...converts waste chemical fines into a salable product





A potash producer salvages seven tons per hour from sub-sized fines. A chemical salt manufacturer effects an 80% recovery of marketable material. Yes, waste becomes valuable when put through the Allis-Chalmers compacting process.

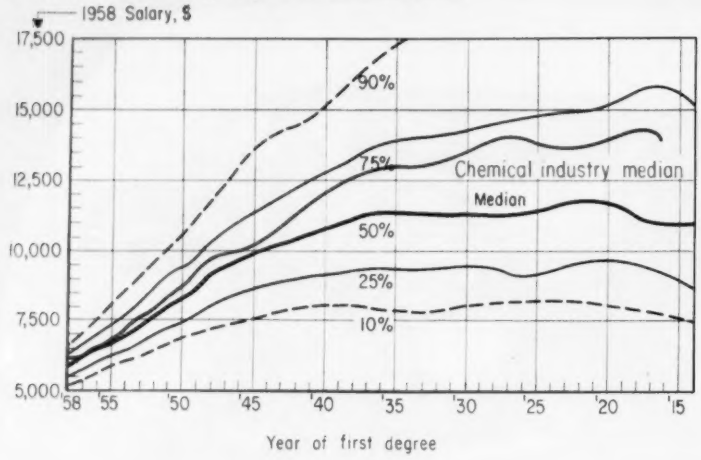
The compacting system is a package of integrated Allis-Chalmers equipment — the remarkable new compacting mill, a roller mill and either a gyratory or vibrating screen. The compacting mill mechanically densifies fines created in your original process. The resulting flakes or slabs are granulated in the roller mill and separated in the screen. Precise control of particle size, density and solubility factors is assured. Recovered product equals or surpasses parent product in every respect.

Get Bulletin 07B8836 from your A-C representative or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin. In Canada, write Canadian Allis-Chalmers Ltd., Box 37, Montreal, Quebec.

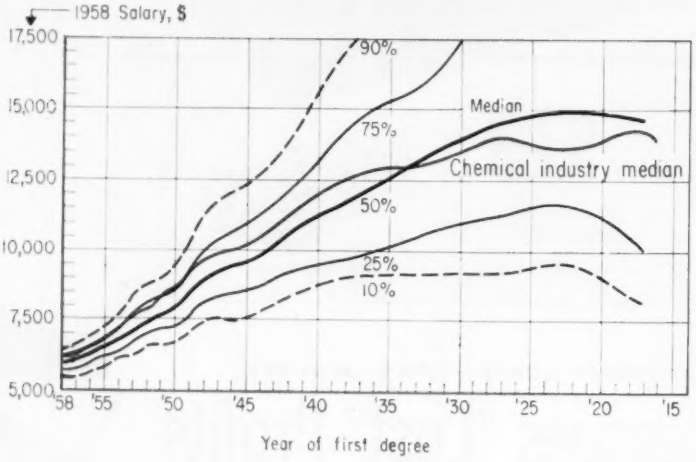
A-C ALLIS-CHALMERS

A-5947

How All of Industry Pays 155,124 Engineers



How Petroleum Companies Pay 13,798 Engineers



ever completed in the U. S. Covered by the survey are 190,810 engineers employed by 546 companies, 131 government agencies and by 382 deans or heads of college departments.

From the survey's 41 tabular and graphic presentations we get the over-all salary profile of the engineering profession, as well as breakdowns for the many industries that employ engineers.

Reliability of the survey is enhanced by the source of the information. Employers, rather than employees, were asked to supply the data. Total payroll sample represents about $2-billion/yr. The survey itself cost Engineering Manpower Commission (under whose sponsorship it was done) about $10,000 of hard-to-come-by budget funds. One large employer of engineers told EJC that it cost somewhere between $1,500-$2,000 to fill out the survey questionnaire properly.

The size of the sample is enormous as most surveys go. Considering the 155,124 industry-employed engineers, this represents about 20% of engineering employment; and thereby constitutes the largest representsensitive sample ever studied in the U. S. from the point of view of salary information exclusively.

Response rates varied greatly within the various industrial activities. Note, however, that half or more of all engineers employed in the chemical process industries are included in the sample.

What the Survey Shows

1958 earnings of engineers continued the upward trend observed in comparing similar surveys done in 1953 and 1956. Over-all median for all graduates was $6,500 in 1953, $7,750 in 1956 and $8,750 in 1958. Increases in earnings, though, are not distributed equally among the various activity classifications, or among the experience levels of the survey.

Younger men are on the steeper slopes of the salary curves. Older engineers are riding the crest of a plateau and after 55 years of age, they begin to fall down the other side of the salary mountain.

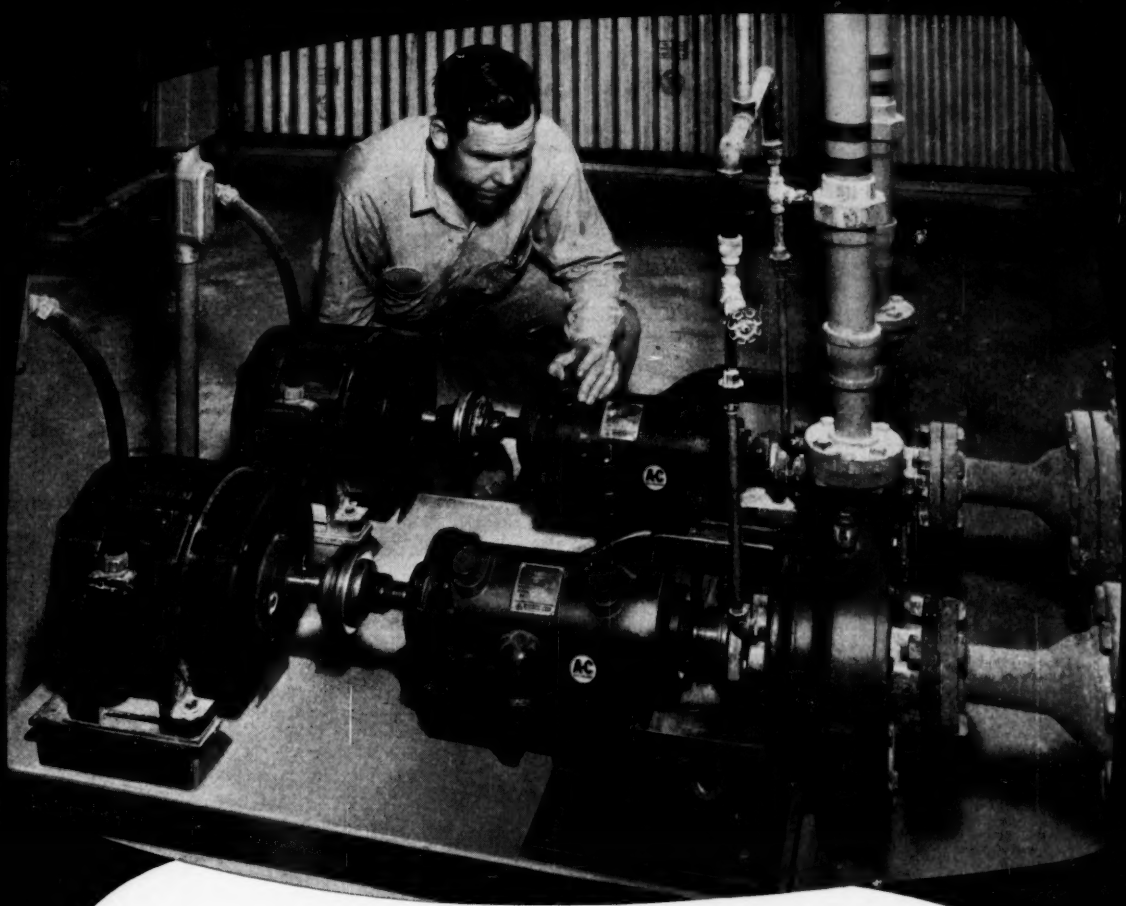
Chemical Industry Tops

With the rigid qualification that what follows in this paragraph concerns all disciplines of engineers employed in the chemical industry and not just chemical engineers, we can confidently make the following statements. The chemical industry pays best. Although in past years the petroleum industry has garnered a reputation for paying its engineers higher salaries than other industries, in 1958 the chemical industry came out tops, with aircraft and petroleum close behind.

In the three charts given so far in this article, we indicate levels for the upper decile, upper quartile, median, lower quartile and lower decile salaries. These can also be considered the lines below which 90%, 75%, 50%, 25% and 10%, respectively, of all engineers in the industry fall.

Income figures on the charts represent the total of base salary and any cost of living allowance and bonus. They do not include any payments for overtime work. These figures are plotted against the year of first degree and, if we haven't already said so, only engineers with degrees are included in the EJC surveys.

EJC's survey definition of an engineer is one who holds a minimum of a B. S. degree in a recognized field of specialization in engineering. Year of entry into the profession is that year in which the B. S. was awarded.



Built to handle YOUR hot pumping job

Here's a *right* line of pumps from Allis-Chalmers for high temperature applications. These oil-lubricated models are of simplified design for easy maintenance — yet offer every feature needed for low-cost handling of hot and corrosive liquids.

Look at these features:

- A wide range of ratings up to 3500-gpm capacity, with heads to 550 feet.
- Impeller material as required — bronze, iron, stainless steel, high nickel alloys and other alloys.
- Get reliable double-row ball bearings guarded by constant level oiler which permits continuous lubricant surveillance.
- Sealing arrangement available from a variety of packings and mechanical seals.

Pump, motor and control are available as a unit from Allis-Chalmers. See your A-C representative or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

A-5778

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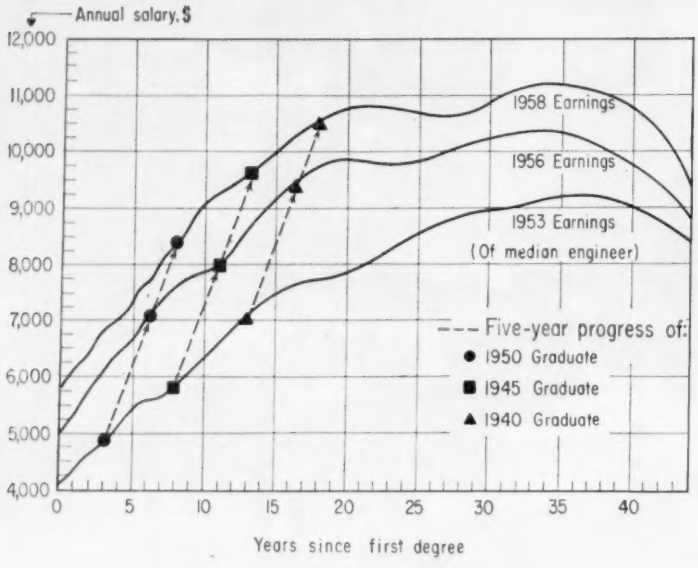
Has Inflation Abolished the Merit Raise?



We're a Young Group

Survey results give us a sharp picture of the typical age and experience level of our profession. The engineering profession has, on the average, mostly youthful practitioners. Median age is somewhere in the mid-thirties.

Approximately 10% of all engineers entered the profession within the last two years; 25% within the last six years; 50% within the last 10; 75% within 23; and 90% within the last 33 years. These facts have important implications. If a man still can be identified by the title of "engineer" after 35 or 40 years in the profession, it's probable that he will be earning less money than younger men in engineering.

We can also reach the conclusion that all the salary curves would be much higher if we could solve the problem of identifying the many engineering graduates who are in management and other executive positions. These men are usually not included in the normal course of replying to the EJC surveys. It's too tough a job for the guy who fills out the questionnaire for a large corporation to spot the manager who originally was a B. S. engineering graduate.

With this third in the series of EJC surveys before us, we are now equipped to make some comparisons of how engineering salaries have changed in the five-year interval of 1953 to 1958. Median salary curves for the survey years of 1953, 1956 and 1958 are shown above.

Obviously, engineering salaries have gone up in five years. But how much? In its conclusions, the EJC report indicates that the over-all average increase for all engineers came to about 6.5%/yr. Here is where we must part company with EJC and strike out to reach some independent conclusions. The EJC method of figuring the increase only partially takes into account one of the basic fundamentals of engineering economics: the time value of money.

Here's what we mean. If an engineer earns $6,000/yr. and gets an increase of $600, that's a 10% increase. But if his employer wants to grant him another 10% increase the following year he must use a compound-interest formula and jack up the raise to $660.

The chart above shows in color the earnings history of three specific engineers. They are the median engineer, Class of 1950, Class of 1945 and Class of 1940. Let's analyze their salary increases taking into account the time value of money. Mr. Median Class of 1950 earned 75% more in 1958 than he did in 1953. "75% divided by 5 years gives 15%/yr.," you might be tempted to say.

That's the lazy way to figure it. The correct analysis is that 75% represents a 12%/yr. raise compounded over five years. Using the same technique, Mr. 1945 has been getting 10%/yr. raises; and Mr. 1940 has been receiving raises of less than 8%/yr.

Has Merit Disappeared?

Our analysis, until now, has not considered changes in the entire spectrum of engineering salary levels. We all realize that the whole engineering salary structure has been displaced upward just because of inflation and the driving force of ever-increasing starting salaries for new graduates.

How much has it been pushed up?

Take the Class of 1950. In 1958 the median 1950 graduate earned 23% more than his Class of 1955 counterpart. This represents a compounded merit increase of 4%/yr. for the preceding five years. We have already determined that the total increase over the same time span was 12%/yr. If 4% was for merit, then 8% was caused by inflation. Similarly, the 1940 median graduate has averaged 10%/yr. Of this, only 2% has been for merit. The Class of 1935 has received less than 1%/yr. for merit.

Perhaps the most striking conclusion that we can draw from this 1958 salary survey, then, is that salary increases based on inflation have all but displaced increases based on merit over the past five years. We know of very few engineers who received both 8% salary increases for inflation in 1958 and an additional 5, 7.5 or 10% on top of that because of high scores in a merit rating program.

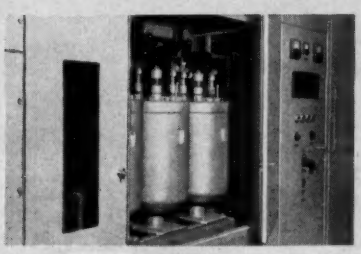
Engineering salaries are on the rise. For this we can all be thankful. But if the merit raise disappears, it will shake the very foundations of corporate wage-and-salary administration policies.

Were you underpaid, paid enough or overpaid in 1958?

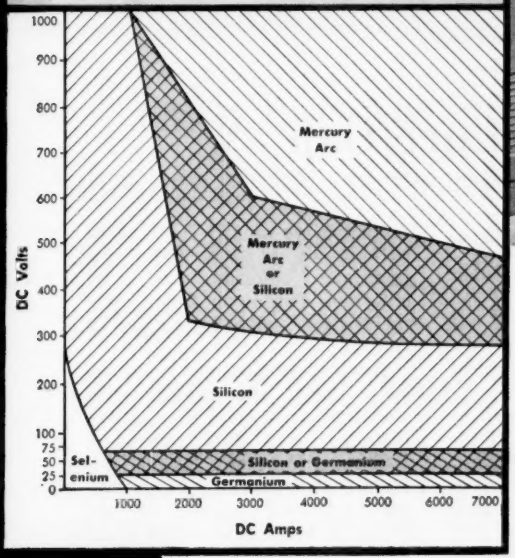
SCOPE in INDUSTRY SPECIALIZATION from...

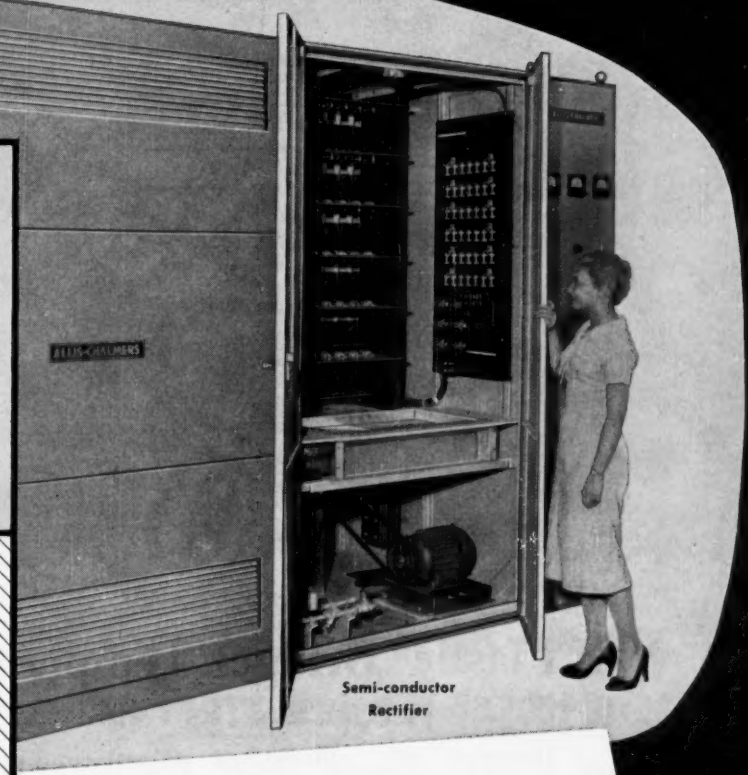
ALLIS-CHALMERS

Open pumped tube Mercury Arc Rectifier



Enclosed sealed tube Mercury Arc Rectifier





Semi-conductor Rectifier

Allis-Chalmers takes the confusion out of power conversion

Right-for-the-job rectifier

Available to Electrochemical Industries

There's only *one* type rectifier that's *right* for your electrochemical application. Use the above chart as a guide. It shows the approximate direct current and voltage ratings that best fit the various types of rectifiers. After checking the chart, check with Allis-Chalmers. Thirty years' experience in developing, building and applying rectifiers equips A-C to analyze your needs and make a pinpoint recommendation.

Allis-Chalmers makes all static types

Allis-Chalmers builds semi-conductor rectifiers such as germanium, silicon, and selenium, as well as mercury arc rectifier units of the pumped or sealed type in open or enclosed construction. Because Allis-Chalmers can supply this wide variety of power rectifiers, our recommendation is always completely unbiased — never influenced by commercial expediency. For complete information, call your A-C man or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin. In Canada, write Allis-Chalmers Ltd., Box 37, Montreal, Quebec.

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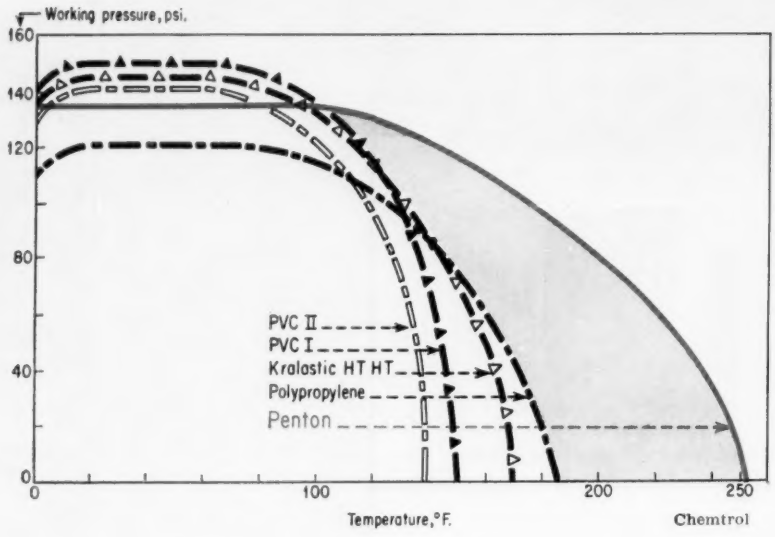
A-5955 C

PRACTICE . . .

CORROSION FORUM EDITED BY R. B. NORDEN



New Plastic Bridges Temperature Gap

Hercules' new chlorinated polyether thermoplastic looks like a most promising material. It can take temperatures up to 250 F.

Anyone considering plastic materials of construction has no easy task. Here is a group of materials with a bewildering array of varieties, changing standards and new developments (see the report on Plastic Pipe, this issue).

We don't wish to complicate this picture any more than necessary. However, we would be remiss if we didn't discuss a new and very promising plastic.

This is Hercules Powder's new chlorinated polyether, Penton* (polybischloromethyl oxetane). Most of the claims for this linear thermoplastic material are impressive, to say the least, even when you consider that plastic-company claims are inclined to be on the optimistic side.

Three Penton properties are of particular interest to chemical engineers:

- It can be easily molded to close tolerances on standard injection and extrusion equipment.
- In chemical resistance it is almost as good as Kel-F and Teflon.
- It can take temperatures of about 250 F., about 100 degrees higher than usual thermoplastics.

An interesting and important point: plant evaluation tests are bearing out the original claims.

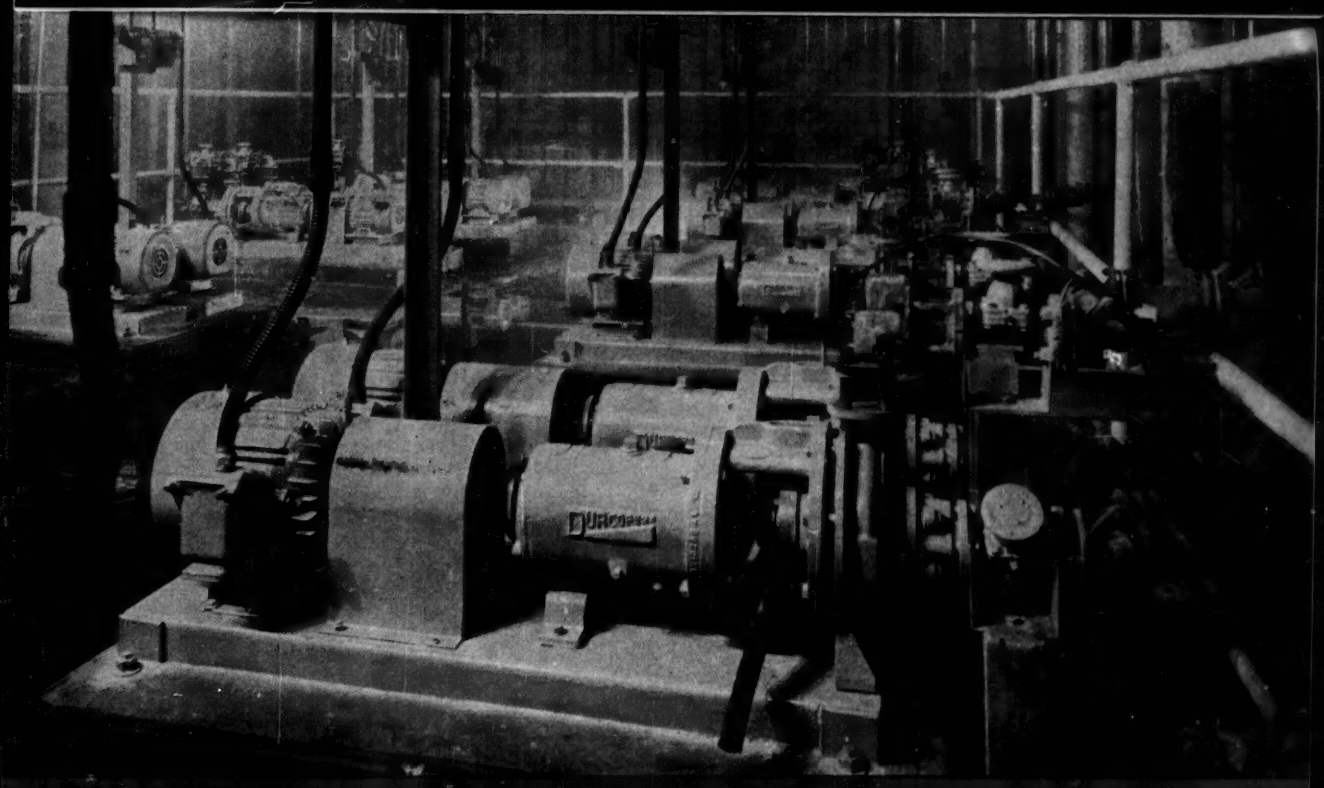
It so happens Hercules' own chemical plants are excellent proving grounds for Penton, although other chemical companies are also putting the plastic through intensive field tests.

A typical application: Penton-lined diaphragm valve in a pipeline commonly using porcelain valves. This line refluxes carbon tetrachloride at 176 F.; but the carbon tet is saturated with hydrogen chloride and wet chlorine. Penton is functioning merrily here without any sign of failure.

Another application: A control valve with all wetted parts machined from solid Penton was installed in a 32% byproduct HCl control system. The off-gas from a chlorination process contains a small amount of wet chlorine, which is absorbed along with the HCl ahead of this control valve. Operating temperature is 90 F. Originally the stem and seat were of a corrosion-resistant alloy, but it quickly failed. Penton parts replaced it and are standing up very well.

One more example: two cast-steel tees, spray coated with Penton inside and out have been installed on the bottom outlet nozzles of glassed-steel chlorination kettles. Hot product discharges and chlorine is introduced via porcelain valves hooked up to the tee. So far no trouble after 6-mo. service.

* Contains 46% chlorine by weight, molecular weight is about 300,000.



THIS IS A PUMPING STATION AT CARBORUNDUM METALS COMPANY. HERE ARE A FEW OF THE MORE THAN FORTY SERIES H DURCOPUMPS USED IN THE PRODUCTION OF ZIRCONIUM. THESE PUMPS HANDLE $ZrOCl_2$ TWENTY-FOUR HOURS A DAY, SEVEN DAYS A WEEK. THE AIR IN THIS AREA IS CONSTANTLY FILLED WITH CORROSIVE CHEMICAL VAPORS. EVEN WITH THIS HARD USE AND CHEMICAL ABUSE, DURCOPUMPS REQUIRE AN ABSOLUTE MINIMUM OF MAINTENANCE.

Series H Durcopumps are chemical pumps all the way. They are designed and built to give long, trouble-free life when handling tough corrosives. They have a large, rugged shaft with minimum deflection, heavy duty bearings, integral suction and discharge with casing support. Durcopumps are adaptable to either packing or mechanical seal.

These pumps are available in twelve standard alloys with interchangeable wet end parts. Capacities range from ½ to 3500 gpm, and heads to 345'. When you have a chemicals handling problem, and want long, dependable pump life, call the Durco service engineer.

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

The mark of dependability in tough chemical service . . . everywhere

THE DURIRON COMPANY, INC. / DAYTON, OHIO

Branch Offices: Baltimore, Boston, Buffalo, Chicago, Cleveland, Dayton, Detroit, Houston, Knoxville, Los Angeles, New York, Pensacola, Philadelphia, and Pittsburgh.

In Chemical Resistance— How Penton Compares

	PVC Type I	PVC Type II	Penton	Kralastic	Polypropylene
Acids					
Acetic, 10%	1	1	1	2	1
75%	1	3	1	4	2
Chromic, 10%	1	1	1	2	1
30%	2	3	1	4	2
Hydrochloric, 35%	1	1	1	1	1
50%	1	2	1	2	1
Nitric, 25%	1	2	2	3	2
70%	2	3	3	4	3
Phosphoric, 10%	1	1	1	1	1
85%	1	1	1	2	1
Sulfuric, 60%	1	1	1	2	2
98%	3	4	2	4	2
Chlorine gas	2	3	2	2	2
Alkalis					
Ammonium hydroxide, 28%	1	1	1	1	1
Caustic soda, 30%	1	1	1	1	1
Ferrous chloride	1	1	1	1	1
Solvents					
Acetone	4	4	2	4	2
Ethyl alcohol	1	2	1	2	1
Carbon tetrachloride	2	4	1	4	4
Ketones	4	4	2	4	3
Toluene	4	4	2	4	
Hydrogen peroxide	2	4	2	4	2

1. Resistant in service to operating limit of material.
2. Resistant to 80 F.
3. Recommend test before installation.
4. Not recommended.

▶Between PVC and Teflon—Actually where does Penton fit into the general plastic picture? Very roughly, from a performance standpoint, it falls into a category between PVC and the fluorocarbons (Teflon, Kel-F).

Take corrosion. There are only about three commonly used chemicals which Hercules does not recommend with Penton: strong nitric (65%), strong sulfuric (98%), and hot ethylene dichloride. Certain other materials can only be used at a temperature lower than the operating temperature limit for Penton (*see table*). Hercules talks about their material having a wide spectrum of corrosion resistance—in the same corrosion league with nickel, better than Hastelloy alloys, and superior to stainless steels.

As to temperature resistance, of course Penton doesn't compare to metals. But it is better than PVC. One equipment manufactures rates Penton parts at a full working pressure rating of 135 psi. up to 100 F., then decreases the rating down to 60 psi. at 220 F. (*see graph*).

On a similar part made of Type I PVC, the rating is 135 psi. at 100 F., then 60 psi. at 140 F. On polypropylene, it is 120 psi at 80 F., then 60 psi. at 160 F.

▶Operating Temperatures—For plastic parts (long-term service) Hercules recommends a maximum operating temperature of 250 F. This is a high and perhaps optimistic temperature compared to 150 F. for PVC, 180 F. for Type II ABS (acrylonitrile-butadiene-styrene), and 185 F. for polypropylene.

Other properties include a specific gravity of 1.4, which is about the same as Type I PVC. Its Izod Impact strength (notched 75 F.) is 0.5, slightly lower than Type I PVC, much lower than the 4 of ABS Type II. Strength (room temperature tensile is 6,000 psi.), expansion (4.4×10^{-4} in./in./F.), notch sensitivity are in the same order of magnitude as Type I PVC, as is hardness and flexural strength.

Also Penton has low water absorption, low permeability, good abrasion resistance.

Hercules believes their plastic has better dimensional stability than most commercially available thermoplastics: the diameter of 2-in. test disks changed less than a mil when subjected to 24-hr. periods of hot humid air (175 F., 90% rel. hum.) followed by 24-hr. of air at −40 F. Under the same test, a fluorocarbon had a 0.02-in. change.

▶Solid or Coated—On fabrication, Penton offers few problems. It can be extruded as well as molded. However, Penton's crystalline structure is such that it solidifies faster at high temperatures than at room temperatures. In molding, a hot mold must be used. You have to extrude into water close to boiling.

Ease of fabrication results in a variety of forms for Penton—pipe, fittings, valves, pumps.

But beside the solid parts, there are three methods for coating.

- One, for small parts, involves coating by dipping into a fluidized bed of polymer resin. This results in a coating 10-40 mils thick.
- Penton can also be flame-sprayed, although this is still in the semicommercial stage.
- And it's available as sheet lining for tanks, valves, piping.

On joining, Penton presents a problem. Up to now no practical solvent or plasticizer has been found. So pipe has been joined by flanging or via screwed fittings. It can also be heat-welded, (melting point is 360 F.).

▶Costs Are High—Penton molding powder costs $6/lb.—which

USCOWELD PLASTIC PIPE FITTINGS

Greater Joint Strength—Faster Insertion—Thanks to

THE ONLY SOLVENT-WELD FITTING WITH AN INTERFERENCE FIT!

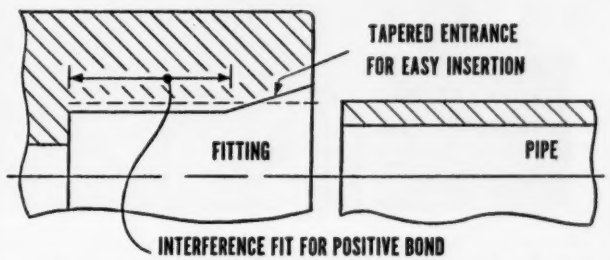
To get maximum joint strength, interference fit is a must! UscoWeld fittings are designed to provide at least a .005 inch *interference fit.* And UscoWeld fittings are a cinch to install because of a specially designed *tapered entrance socket.* U.S. Rubber has developed the unique UscoWeld fitting of the same tough, lightweight, corrosion-resistant thermoplastic as famous Uscolite® CP plastic pipe.

All UscoWeld fittings can safely handle the pressures recommended for the corresponding size of extra-heavy Uscolite pipe. Maximum recommended operating temperature is 170°F. Pipe can be cut to exact length, is easily installed in close quarters.

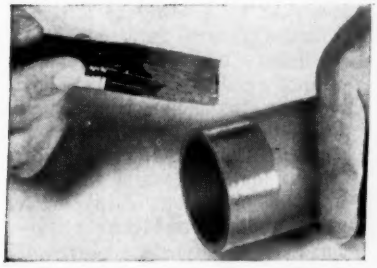
UscoWeld*—plus the most complete line of plastic pipe and fittings in America—is obtainable through your local "U.S." Distributor, any "U.S." Branch, or write us at Rockefeller Center, New York 20, N. Y. In Canada: Dominion Rubber Co., Ltd.

*Patent applied for

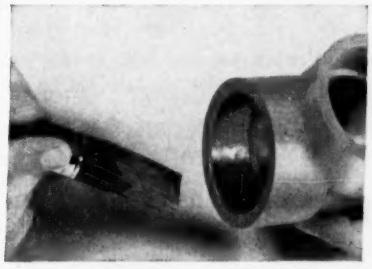
THE USCOWELD PRINCIPLE



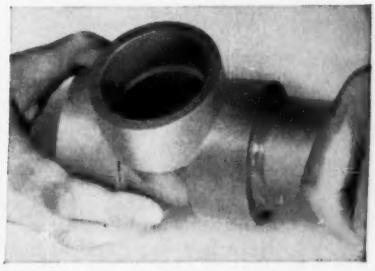
By combining tapered entrance socket and a .005 inch interference fit—even when the pipe is at the small limit of the diameter tolerance and the fitting at the large limit of its diameter tolerance—UscoWeld is easily installed, and the strongest solvent-weld joint available.



Apply Uscolite CP cement to the outside area of the pipe that is to be in contact with the socket.



Next apply cement uniformly to entire inside area of *tapered entrance* socket.



While both cemented surfaces are still wet, insert pipe in fitting and push until pipe bottoms against shoulder in the fitting.

ADVANTAGES

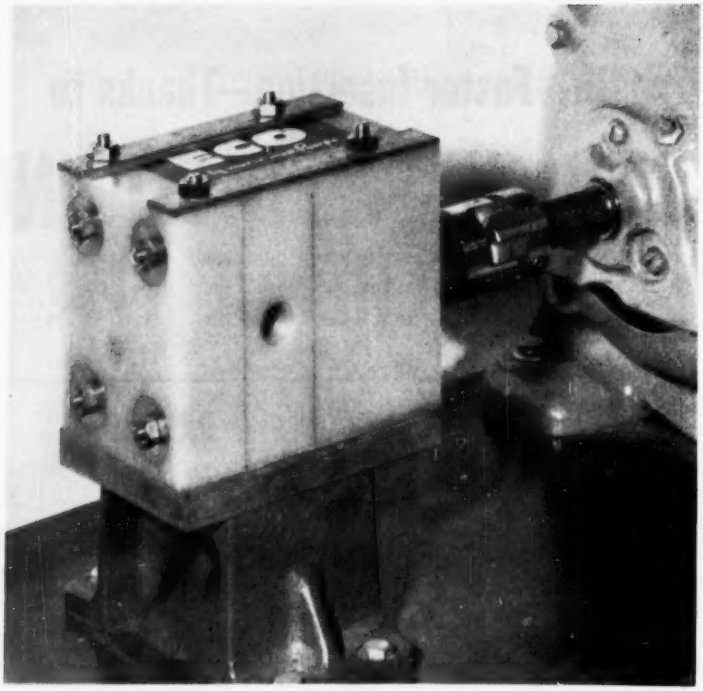
- fast, easy to assemble—tapered entrance provides easy insertion of pipe
- strong joint—interference fit provides for optimum fusion of pipe and fitting into homogeneous mass; joint strength not dependent on cement alone
- automatic alignment of pipe and fittings
- chemical resistance of the UscoWeld joint is the same as for Uscolite pipe
- UscoWeld takes maximum advantage of the inherent "solvent-weldability" of plastic pipe and fittings
- no threading required—just cut pipe square
- not necessary to allow for thread make-up variation—pipe can be cut to exact lengths
- easy to install in close quarters
- resists fatigue due to vibration or thermal stresses by elimination of stress concentration at thread roots.

Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.



In Equipment: pumps, valves, piping . . .

Hercules is going after the corrosion market with Penton, a chlorinated polyether thermoplastic. Lower in cost than stainless, after fabrication, new material stands up to everything except strong acids.

is expensive. Teflon is about $4.50/lb., Kel-F about $7/lb. When volume production and sales are reached, Penton could be around $3/lb.

At any rate, on cost, it appears to be in the Kel-F, Teflon class for the time being.

Here is a hypothetical but interesting analysis for the cost of Penton parts. On a price/cu. in. basis Penton is 30¢, Kel-F is 59¢, Teflon 35¢, Type 316 stainless 23¢, Nickel 38¢ and Hastelloy C, 80¢.

Now pick a valve. Assume a pound of Penton will be needed for such a valve, so actual material cost is $6. Correcting for density, you would need $4.60 of Type 316 stainless (80¢/lb.). The metal must be machined from metal castings and assume a 15% loss here (70¢), then add $3.45 for labor and machining. On the plastic valve there is only $1 for molding, as a conservative estimate.

So the final mill cost for a Penton valve would be $7; for an equivalent stainless alloy, $8.75.

Of course, this analysis assumes you are making a stainless valve identical in size and thickness to Penton.

Actual prices for valves seem to prove this analysis is correct. List price for a 2-in. screwed Penton ball valve is $74, compared to a stainless 316 cost of $106. Flanged valves costs: $100 for Penton, $160 for stainless 316.

For pipe, Penton seems promising as a lining material. Prices per ft. of 2 in. dia., sch. 40 pipe are as follows:

- Steel lined with 50 mils Penton—$3.90.
- Type 316 stainless—$7.54.
- Nickel—$7.22.

Setting their sights high, Hercules is going after the corrosion market in a big way. They see a potential for 5-million lb/yr. of Penton eventually as a replacement for metals.

New Steels Excellent For High Temperatures

Dubbed SR for Super-Rust-free, a new group of steels has been introduced for high-temperature corrosive service.

Some of the claims made for the materials: They cost considerably less to produce than super alloys. They use none of the so-called critical metals such as cobalt, columbium, tantalum, tungsten or zirconium and only relatively small amounts of nickel.

Uniworld Research Corp. of America (Cleveland), the developer of these steels recently announced a licensing agreement with Thompson Ramo Wooldridge Inc. for the exclusive production of castings of SR steel alloys. Thompson's Kolcast Div. will produce the steel castings by their frozen mercury investment process. But they also have exclusive right to sub-license the use of SR steels in the entire casting field for sand, shell and centrifugal castings.

The new steels are austenitic, nonmagnetic, even after severe cold working.

They are age-hardenable. One alloy (13% nickel) can be age hardened by holding at a temperature, from a fully annealed condition.

Another alloy (5% nickel) has an as-cast tensile strength of 112,000 psi. and a yield strength of 44,000 psi. A different alloy has an as-cast tensile strength of 82,000 psi. and a yield strength of 60,000 psi. and can be age-hardened to a tensile strength of 120,000 psi. and to a yield strength of 105,000 psi.

SR steels are claimed to have a higher short-time strength than stainless grades in the temperature range of 1,200 to 1,600 F.

The steels are available for use in other fabricated forms such as plates, sheets, foils, bars, rounds, wire and powder.

In addition to suitability for many missile and aircraft parts, Uniworld claims the high temperature properties and corrosion resistance to sulphuric acid, sea water and other corrosive substances make their steels a prime material of construction for the chemical industries.

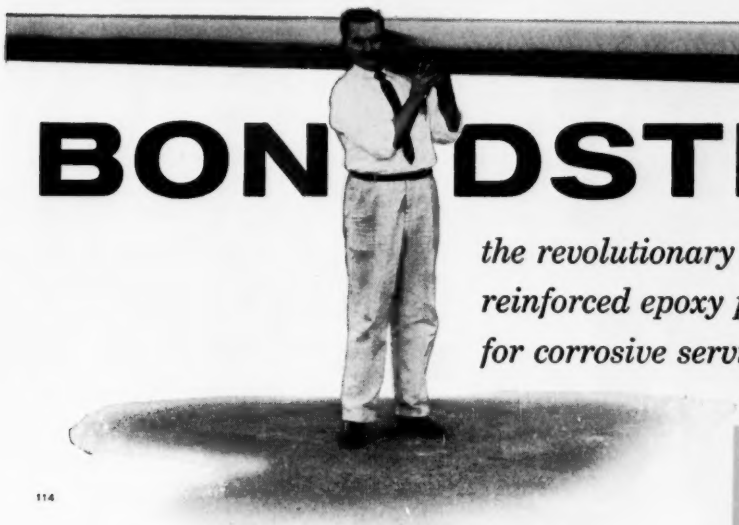
STRONG as steel pipe

...at one-eighth the weight!

Circumferential Tensile Strength... 80,000 psi

BONDSTRAND®

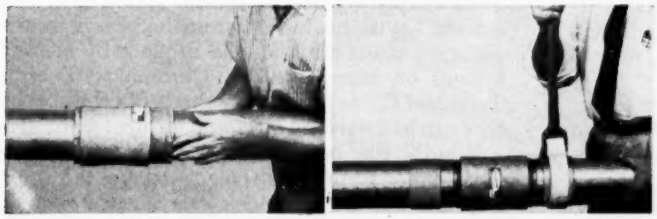
the revolutionary fiber glass reinforced epoxy pipe for corrosive service



114

Here's a pipe that holds up indefinitely under the corrosive action of many salt, acid and alkaline solutions... that can't contaminate or flavor the piped material... that is rigid enough to resist sag, cold flow or deformation – flexible enough to follow normal ditch contours... that remains smooth and unclogged throughout its entire service life... that won't leak, even near its burst pressure.

Easy to install, with choice of locking wedge or threaded fittings.



Simple instructions with each shipment insure a perfect joint on the first try.

IN THE CHEMICAL INDUSTRY...

This means that you can use BONDSTRAND to transport corrosive solutions, waste water, sewage, oils, foods, beverages and many other troublesome fluids. It's also ideal for ducting, conduit or handrails where corrosive atmospheres, condensation, spillage or immersion cause troubles with ordinary pipe.

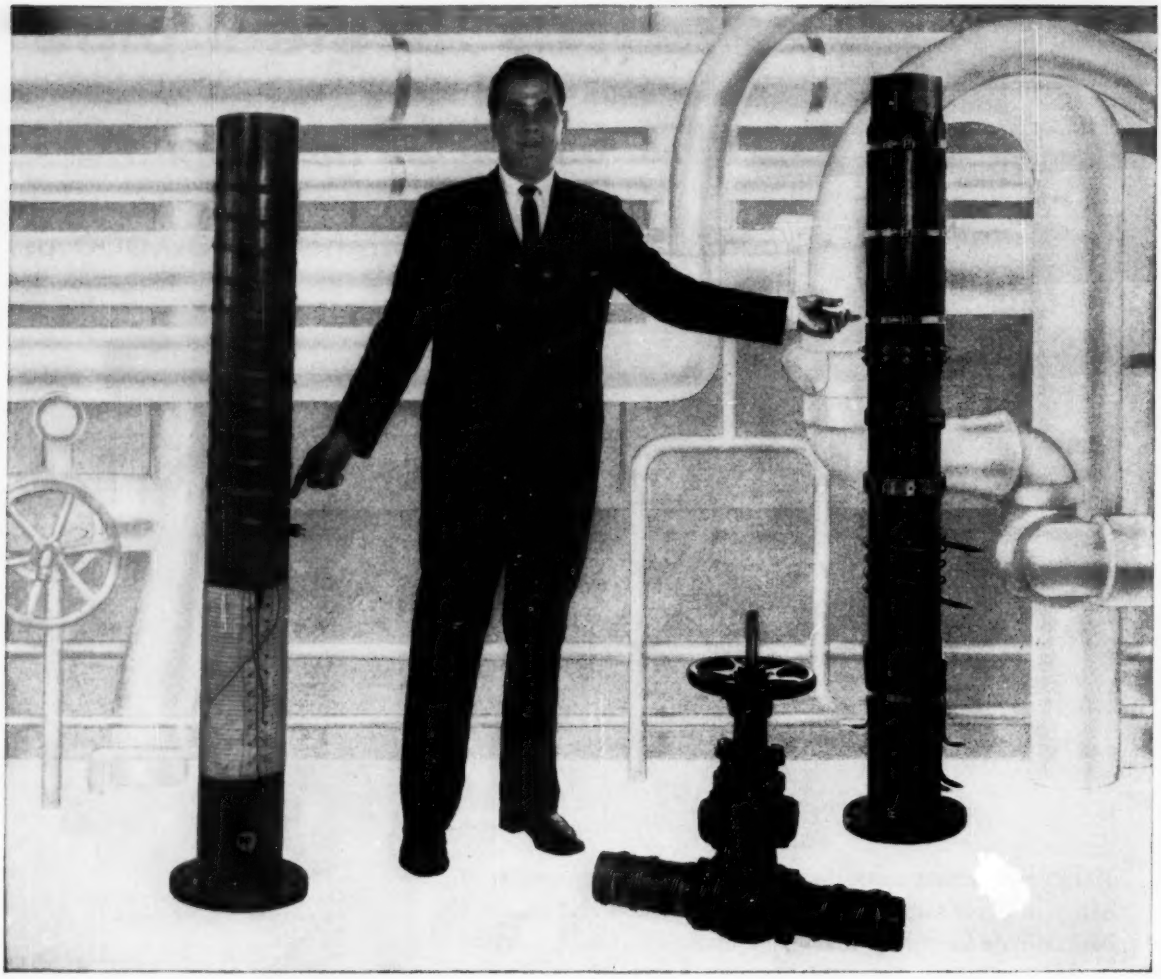
Amercoat® CORPORATION

Dept. AC • 4809 Firestone Boulevard • South Gate, California

921 Pitner Avenue, Evanston, Illinois
360 Carnegie Avenue, Kenilworth, New Jersey
2404 Dennis Street, Jacksonville, Florida
6530 Supply Row, Houston, Texas

A Subsidiary of American Pipe & Construction Company

What's the best way to heat a pipe?



Your CHROMALOX Man has the Answer

Each of the above pipe heating methods has particular advantages. Your Chromalox Man can help you determine the one best electrical answer to your individual problem.

Maybe Chromalox Strip Heaters best meet your operating conditions. Quickly and easily installed at low initial cost, they provide uniform, accurate temperatures by either automatic or manual control. Lengths from 4″ to 96″ can be clamped in place side by side, or, half-round strip heaters may be bolted together to a minimum inside radius of 3½″. Sheath material and terminal placement vary according to your application.

Or perhaps Chromalox Tubular Heaters are the answer. These versatile heaters are available in straight lengths or bent to any shape you may require. Only Chromalox Tubular Heaters have the patented triangular cross-section that puts more heater area into surface contact for maximum heat transfer.

Still other pipe heating problems can be solved quite simply by one of several Chromalox "wrap-around" type heaters. Chromalox Pre-Fab woven electric heaters may be held in place by lacing, adhesives or snap-fasteners. Chromalox Thermwire Tape and Cable answer hundreds of other problems that can be solved by low temperature localized heat.

What's the best way for *you*? Just call your Chromalox Representative, listed on the opposite page. He has the fast, clean, safe, accurate, economical ELECTRICAL ANSWER. He's backed by the world's largest stock of industrial electric heaters, ready for immediate shipment. And, he offers factory design engineering service for special applications.

2822

CHROMALOX
Electric Heat
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Edwin L. Wiegand Company
7514 Thomas Boulevard • Pittsburgh 8, Pa.

Call Chromalox

for the man with the
ELECTRICAL ANSWERS
to your heating problems

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Prospect 1-7112

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L. R. Ward Company
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Diamond 6-9606

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Broadway 1-3021

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115 S. Highland Ave.
Emerson 1-2900

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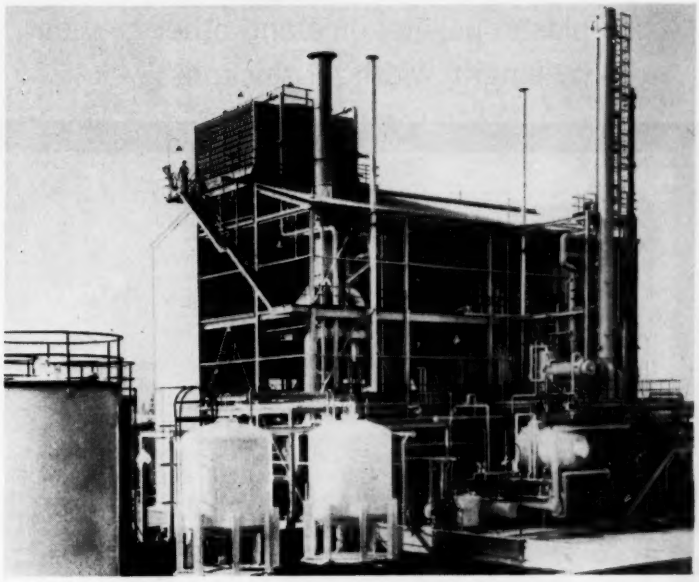
2622

FIRMS IN THE NEWS

R. A. LABINE

NEW FACILITIES



Shell Chemical Displays New Semi-Commercial Unit

In a new $2-million semi-commercial plant in Martinez, Calif., Shell Chemical Corp. is now turning out market development quantities of several promising chemicals stemming from Shell research. First run of products from the flexible manufacturing unit included several derivatives of acrolein.

Southern Nitrogen is in final stages of expanding ammonia production at its Savannah, Ga., plant by 20-25%. In addition, Southern Nitrogen is introducing two new products: Solid nitrogen material containing 20.5% nitrogen plus dolomitic limestone, and solid urea for chemical and animal feed applications.

Hercules Powder and Stauffer Chemical will form a new company to make aluminum trialkyls and other aluminum alkyls in a 1-million-lb./yr. plant at an undetermined location. The alkyls, used as intermediates in polymerization catalysts, will be made by a process patented by Germany's Karl Ziegler.

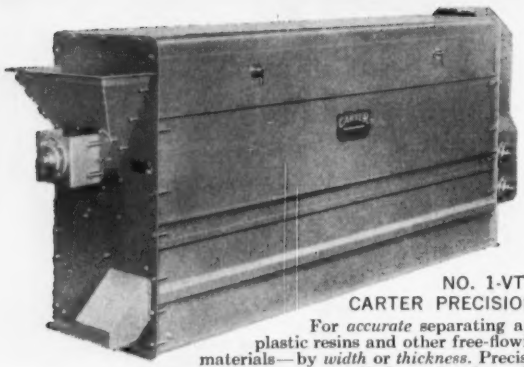
Mobay Chemical Co. plans a 50% expansion in capacity for producing tolyene diisocyanate (TDI) at its New Martinsville, W. Va., plant; TDI is a basic material for the production of urethane foams. A similar 50% expansion was completed by Mobay in the fall of 1958.

American Cyanamid has broken ground at Bound Brook, N. J., for its new multimillion-dollar anthraquinone plant that will double Cyanamid's annual production of this chemical. The construction of the new plant is expected to be completed late this year.

Monsanto will boost capacity for high-pressure polyethylene at its Texas City, Tex., plant to 100 million lb./yr.

THESE SIMON-CARTER MACHINES CAN STEP UP YOUR QUALITY CONTROL

Automatic separating and sizing of plastic pellets, dice and other shapes by length, width, or thickness.

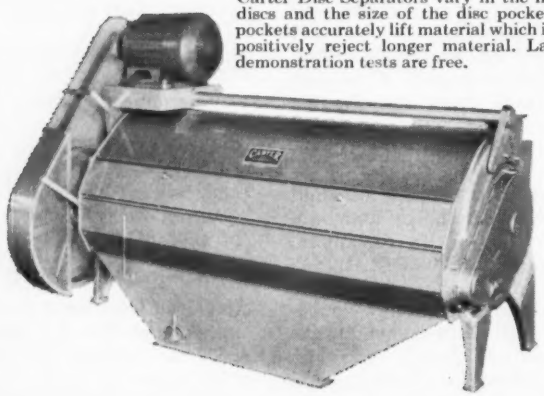


NO. 1-VT
CARTER PRECISION GRADER

For *accurate* separating and sizing of plastic resins and other free-flowing granular materials—by *width* or *thickness*. Precision Graders separate by means of cylinders of unique designs with either round or slotted perforations. Various models and sizes—including multiple units—are available.

CARTER DISC SEPARATOR

For *accurate* separating and sizing by *length*. Carter Disc Separators vary in the number of discs and the size of the disc pockets. These pockets accurately lift material which is shorter, positively reject longer material. Laboratory demonstration tests are free.



WRITE TODAY for complete information, giving us a brief description of your sizing problem.

SIMON-CARTER CO.

661 19th Ave. N.E. Minneapolis 18, Minn. STerling 9-2417

FIRMS . . .

Expansion will be completed by the third quarter of this year and will include "several significant high-pressure technical advances."

Byron Jackson Pumps, subsidiary of Borg-Warner Corp., has placed a new "clean room" in service at its Los Angeles plant for final assembly of nuclear and cryogenic pumps under ideal environmental conditions.

Pennsalt Chemicals, which completed its first ammonium perchlorate plant last October, plans a "major expansion" of the five-month-old plant at Portland, Ore., upping capacity by "several thousand tons." Ammonium perchlorate is the most widely used oxidizer for solid propellants.

Union Carbide is building a plant to produce polyethylene film at Cartersville, Ga., about 40 mi. northwest of Atlanta. Plant is slated for completion in July of this year and will employ about 100 people when in full production.

Dow Chemical has placed on stream in Cleveland, Ohio, its firs plant for making "Trycite" polystyrene film. Dow has been supplying the film from pilot facilities in Midland, Mich.

Arkansas Fuel Oil is heading a group that will build a $1.3-million, 34,000-Mcf./day gas

processing plant southeast of Kingsville, Tex., adjacent to AFO's May Field separation unit. Plant, designed to yield 29,000 gal./day of liquids, is slated to go on stream in October.

Stauffer Chemical Co. is investing approximately $2 million to expand and modernize its Niagara Falls plant. Project, when completed late this year, will add about 25% to company's capacity to produce caustic soda and chlorine at Niagara Falls.

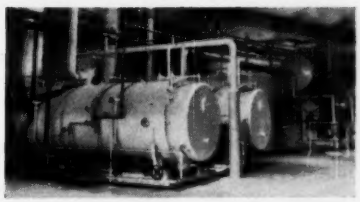
Shell Oil has construction under way on its natural gas processing plant in the Weeks Island Field (La.). When completed, unit will have a capacity of 120 Mcf./day.

General Electric will explore many aspects of nuclear radiation in a new $1.5-million laboratory at Schenectady, N. Y. Among the facilities are a 10,000-curie cobalt-60 source and two 1-mev. particle accelerators. Researcher above inspects aluminum basket which holds objects for irradiation by the cobalt-60 source.

Kaiser Aluminum & Chemical will build a coke calcining plant near Purvis, Miss., to supply anode-grade carbon for use in company's electrolytic reduction pots. Plant, to be on stream in six months, will have a 70,000-ton/yr.

1st choice for steam in world's largest dome

Matched pair of 200 hp Cleaver-Brooks boilers picked to supply steam for cleaning tank cars and for heating, too, at Union Tank Car's great new repair center in Baton Rouge, Louisiana



This fabulous structure houses the most modern of tank car repair facilities. The two Cleaver-Brooks packaged boilers provide low-cost process steam for cleaning tanks — eliminating residual acids, volatile and tenacious liquids or near-liquids.

Their high-capacity performance not only meets the demands for efficiently produced steam for cleaning (guaranteed 80%), but also provides steam for heating.

Because of packaged design, the two 200-hp units (delivering 150 lbs. pressure) were easy to install, occupy minimum floor space. And the boilers are fired by either oil or gas . . . thus, providing operational flexibility regardless of available supplies.

So far, Union Tank Car has used steam from the Cleaver-Brooks boilers to clean out cars that have transported petroleum products, chemicals, coal tar products, vegetable oils and liquid fertilizers.

The choice of the Cleaver-Brooks boilers was underwritten by their combination of remarkable compactness, automatic operation, wide-range flexibility and around-the-clock reliability.

If you'd like to know more about this installation or how Cleaver-Brooks packaged boilers (15 to 600 HP) fit into your expansion or replacement plans, write Dept. C, 345 E. Keefe Ave., Milwaukee 1, Wisconsin.

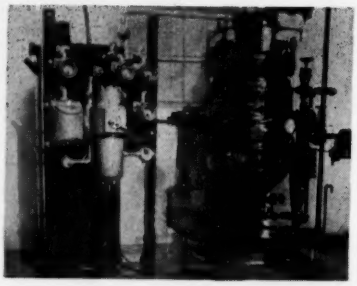
Cleaver Brooks®

ORIGINATOR AND LARGEST PRODUCER OF PACKAGED BOILERS

PRODUCT IMPROVEMENT WITH PETRECO

FACT-FINDING... FIRST HAND!

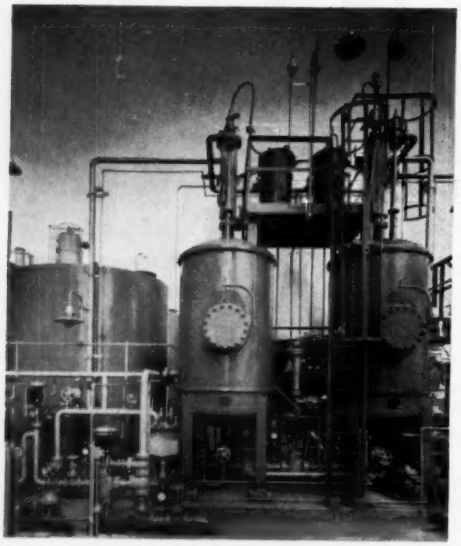
Getting the processing facts quickly and at minimum expense is a prime virtue of this Electrofining Process Pilot Plant. In contrast to its relatively small volumetric capacity (60 gallons), it has demonstrated astonishing throughput processing capacities.



ELECTROFINING precipitator pilot plant efficiently, economically pre-tests processing possibilities*

If you have a processing problem involving the contact of a hydrocarbon stream with chemicals, and the subsequent separation of the mixture, *get the facts on ELECTROFINING Equipment today*. The equipment insures intimate and instantaneous contact, thorough mixing, and a clean, immediate separation with minimum carry-over or effluent pollution. Processing is precise, automatic and continuous.

*ELECTROFINING *is a registered trademark of the Petrolite Corporation.*



COMMERCIAL ELECTROFINING EQUIPMENT

Note small space occupied by this installation. Its throughput is approximately 2500 barrels per day.

FOR MORE INFORMATION

write or call . . .

PP-59-2

PETROLITE CORPORATION

CANADA: Petreco, 4528 Stanley Drive, Calgary, Alberta
ENGLAND: Petrolite Limited, 46 Mount Street, London, W. 1
VENEZUELA: South American Petrolite Corporation, Hotel Avila, Caracas

PETRECO DIVISION

3202 South Wayside Drive, (P. O. Box 2546), Houston 1, Texas

1390 East Burnett Street (P. O. Box 7216), Long Beach 7, California

Representatives also in Brazil, Italy, Japan, Kuwait, Mexico, Netherlands and Trinidad

capacity and cost about $500,000.

Union Carbide Metals Co. has tripled production facilities for high-purity (ductile) vanadium at its Niagara Falls, N. Y., plant. Carbide says development of nuclear energy uses have contributed to rise in demand.

Du Pont has started up its new multimillion-dollar sodium and chlorine plant at Memphis, Tenn., increasing Du Pont's production capacity by about 50%. Part of the additional chlorine capacity will be used in making titanium dioxide pigments at firm's new 45,000-ton/yr. plant nearing completion at New Johnsonville, Tenn.

Imperial Oil is building an asphalt plant, with annual capacity of 125,000 bbl., at its Winnipeg refinery. Plant is slated to go into operation in May.

Federal Uranium Corp., Salt Lake City, has selected Western Knapp Engineering Co., San Francisco, as prime contractor on its 522-ton/day uranium mill in Wyomings's Gas Hills District. Mill, to cost $3 million, will use a resin-in-pulp process.

Du Pont plans to erect a 15-million-lb./yr. "Orlon" acrylic fiber plant in Dordrecht, The Netherlands. Plant, to be in operation in the last quarter of 1961, will be operated by a Du Pont subsidiary soon to be formed.

Linde will build a liquid oxygen-nitrogen plant near Huntsville, Ala., in the vicinity of the Redstone Arsenal to be completed early in 1960. Capacity: 100 million cu. ft./mo. oxygen and nitrogen.

Westinghouse will build a 5,000-kw. nuclear reactor plant for the General Public Utilities system at its power station now in operation near Saxton, Pa. Steam from the pressurized-water reactor will be fed to an existing turbine-

generator set. Reactor is scheduled to go into operation during the summer of 1961.

Air Reduction has completed its new high-purity oxygen-nitrogen plant in the Armourdale district of Kansas City, Kan. Unit replaces an older Airco facility in Kansas City, Mo.

W. R. Grace's Davison Chemical Div. is building a $500,000 addition to its present fertilizer plant at Ft. Pierce, Fla. New facilities will turn out granulated fertilizers; existing equipment produces conventional ground fertilizers.

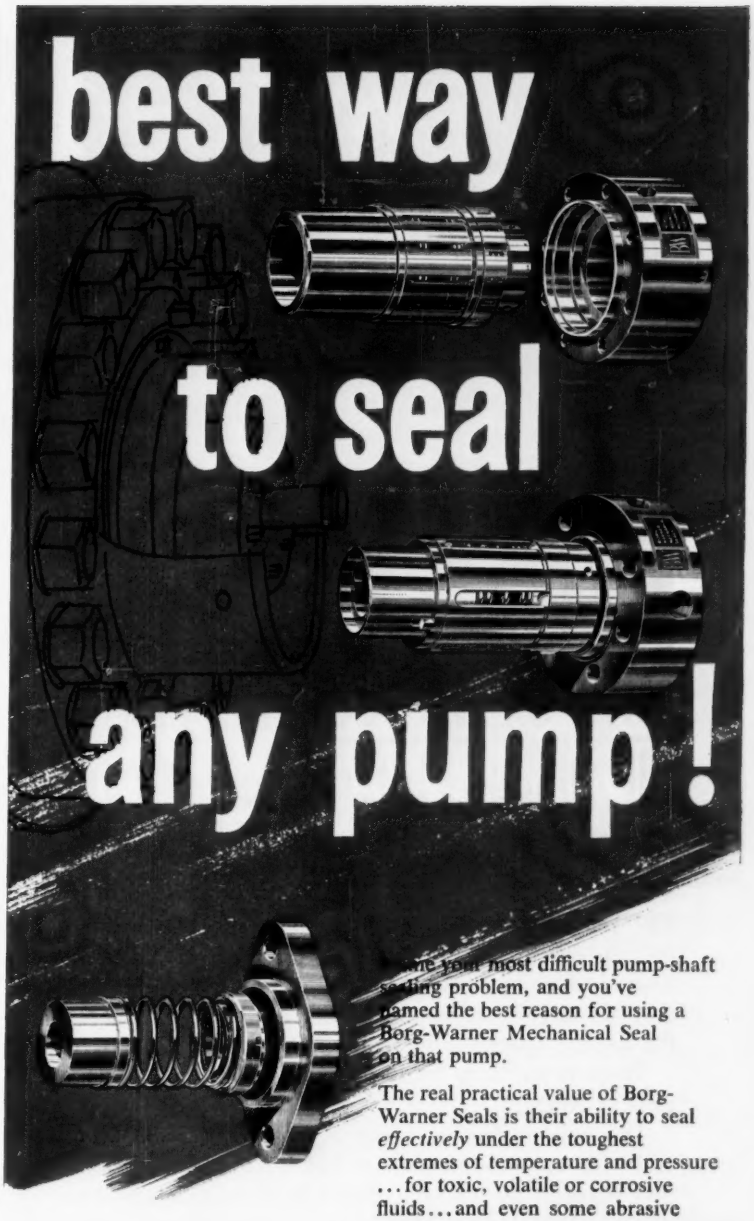
Ethone, Inc., subsidiary of American Smelting & Refining Co., has just completed a new research laboratory at its main plant in New Haven, Conn. Lab triples firm's research facilities for developing new metal finishing compounds and processes.

Diamond Alkali plans to spend $2 million modernizing its chlorine-caustic soda facilities at Painesville, Ohio. Modernization, already in progress, means replacing the 30-yr.-old Tucker-Windecker cells with Diamond's own 30,000-a. rectangular cells.

J. R. Simplot Co., Boise, Idaho, is planning to build a 200-ton/day sulfuric acid plant at Pocatello, Idaho. Plant will give the firm a fully integrated superphosphate operation for the first time in its postwar fertilizer production program.

High Voltage Engineering Corp., manufacturer of radiation-producing particle accelerators, announces plans to establish a manufacturing plant in Amersfoort, The Netherlands. Move will enable firm to provide more services for over 30 installations in Europe, Africa and the Near East.

Kaiser Chemicals is expanding basic refractory brick capacity at its Columbiana, Ohio,



...ame your most difficult pump-shaft ...ling problem, and you've named the best reason for using a Borg-Warner Mechanical Seal on that pump.

The real practical value of Borg-Warner Seals is their ability to seal *effectively* under the toughest extremes of temperature and pressure ... for toxic, volatile or corrosive fluids ... and even some abrasive liquids. *Result*—less down time, elimination of expensive stuffingbox maintenance, and savings of the pumped fluid.

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NOW AVAILABLE—a new file folder of Borg-Warner Mechanical Seal designs shows some of the many types and applications possible for pumps, mixers, autoclaves and for special rotating shaft problems. Send for your copy today—there's no obligation!

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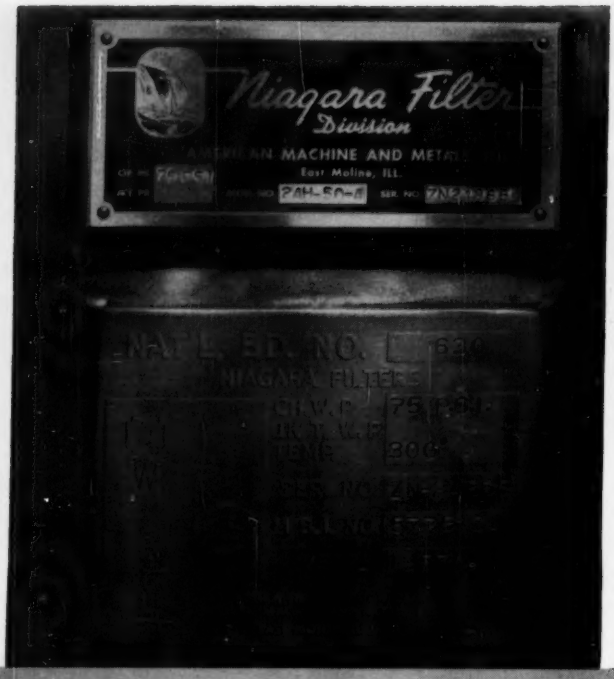

WITH OR WITHOUT THIS PLATE

all Niagara filters are built in strict accordance with ASME Code

The same ASME approved material and construction go into *every* Niagara filter. Welding of all Niagara filters is done by certified welders and all units, whether they are to be code stamped or not, are tested at *double* the normal operating pressure.

There is no "code equivalent" for ASME Code Standards at Niagara.

The only difference between a Niagara filter with and without the ASME plate is that it must be inspected and stamped by National Board inspectors before the plate is affixed.

The choice of having an ASME plate affixed is yours at nominal extra cost.

See Chemical Engineering Catalog for facts on Niagara Filters, or write us today, outlining your requirements.

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American Machine and Metals, Inc.

Dept. CEN-359, EAST MOLINE, ILLINOIS
(Niagara Filters Europe: Kwakelpad 28, Alkmaar, Holland)

SPECIALISTS IN LIQUID-SOLIDS SEPARATION BY PRESSURE-LEAF, PLATE and ROTARY VACUUM FILTRATIONS and CENTRIFUGAL EXTRACTION

plant for the second time in three years. Project will cost about $750,000.

Blaw-Knox's Chemical Plants Div. has been awarded a contract to design and build an addition to the soybean processing plant of Quincy Soybean Products Co., Quincy, Ill. New facilities will increase plant capacity from 750 to 1,200 tons of soybeans per day.

Nopco Chemical's Plastics Div. has construction under way at North Arlington, N. J., that will triple size of the present plant, expanding six times the present capacity for making polyurethane foams and permitting expansion of facilities for foamed-in-place systems.

Plastic Papers, Inc., has completed its new 27,000-sq.-ft. polyethylene coating plant in Hicksville, N. Y., headquarters of the firm. Among products will be coated paper, board and foil.

Allied Chemical's Barrett Div. has started construction on a new gypsum calcining plant at Edgewater, N. J., that will process ore directly from ships coming from Nova Scotia. Dockside unloading facilities can handle 900 tons/hr. ore.

Atlas Powder Co. and Standard Oil of Ohio have organized Solar Nitrogen Chemicals, Inc., equally owned by both companies. New firm will manufacture and sell agricultural and industrial chemicals and will acquire all of Sohio's present ammonia and related petrochemical facilities at Lima, Ohio.

Vitro Corp. of America has acquired Crane Co.'s interest in

Heavy Minerals Co., Chattanooga, Tenn., giving Vitro 87.5% ownership. Heavy Minerals produces rare earth chemicals, thorium and heavy minerals.

Continental Oil Co. has formed a Dutch subsidiary to operate in Europe. New firm is called Continental Oil Co. (Nederland), N. V., and is headquartered in Rotterdam.

National Research Corp., Cambridge, Mass., has formed a Metals Div. to consolidate production and marketing of NRC's high-purity tantalum, its alloys, and other rare metals.

Rexall Drug Co. has completed negotations for acquisition of Chippewa Plastics, Inc., of Chippewa Falls, Wis., subject to Chippewa stockholder approval.

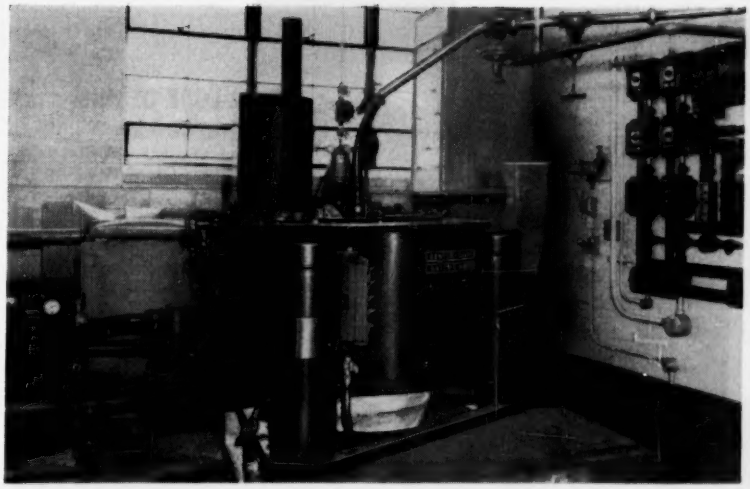
Du Pont has organized a Swiss sales company, Du Pont de Nemours International, S.A., to plan and implement European sales programs for products to be manufactured by Du Pont subsidiaries in Europe, and for products manufactured in the U. S.

Air-Formed Products Corp., Nashua, N. H., is a new company that will specialize in the design, manufacture and sale of equipment and services to the plastic blow-molding industry.

Atlas Powder Co. has established an International Div. to handle all of its international sales and to coordinate all of the parent company's activities with foreign affiliates.

Wyandotte Chemicals has completed negotiations for purchase of the Atlanta, Ga., plant of Tesco Chemicals, Inc. Purchase includes the Tes-Ted line—dishwashing, maintenance cleaning and automotive products.

Flintkote Co. will acquire, subject to stockholder approval, the Blue Diamond Corp.—



Abbott Laboratories ends STOP-AND-GO production with NEW BATCH-O-MATIC®

This 48" Tolhurst Center-Slung Batch-O-Matic Centrifugal eliminates production interruptions between loads of Pro-Gen®, a widely used livestock feed supplement manufactured by Abbott Laboratories.

IMPROVED QUALITY CONTROL

Abbott also reports more uniformity in color and moisture content as a result of using the new Tolhurst centrifugal.

By replacing 3 manually operated centrifugals, the new Tolhurst Batch-O-Matic gained a 50% saving in floor space and a 33% saving in manpower. At the same time, the automatic plow results in quicker and safer unloading than was possible with manual machines.

For more complete data, see Tolhurst's Section in Chemical Engineering Catalog or write.

"BATCH-O-MATIC" registered trademark of American Machine and Metals, Inc.
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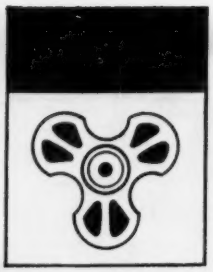


3-LOBE DESIGN

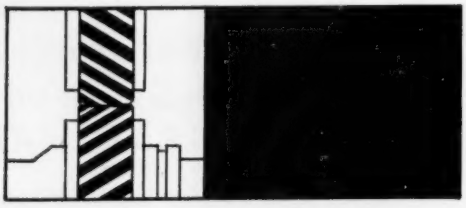
Exclusive M-D 3-lobe design adds strength—reduces torsion. Dynamically balanced rotor permits higher speeds —greater pressures.

DUCTILE IRON

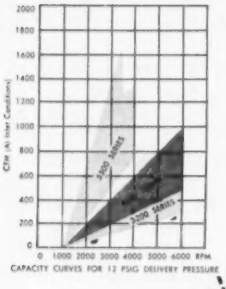
Only M-D uses ductile iron rotors. Only M-D rotors are cast with lobe and shaft integral—no pins to work loose. Makes M-D blowers safest at high speeds.

HELICAL GEARS

Every M-D blower shipped has a matched pair of crown-shaved, lapped helical gears. Backlash tolerance is .0005" to .0015". No other blower matches M-D quality.

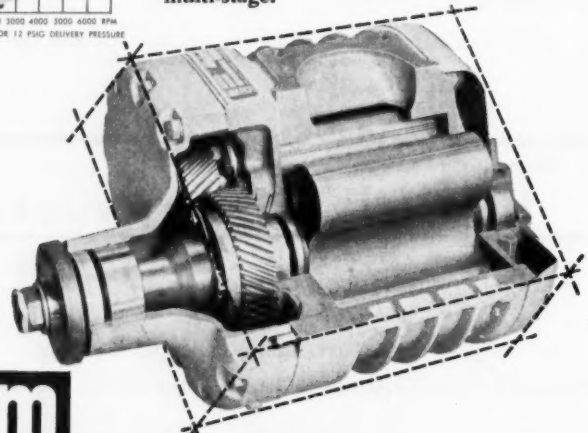


WHY M-D ROTARY POSITIVE BLOWERS DEVELOP HIGHER PRESSURES...



The unique combination of precision manufacture and modern design found only in M-D rotary positive blowers permits higher speed operation and higher pressures. For this reason M-D can furnish greater air flow at lower initial cost.

M-D blowers operate at wider pressure and speed ranges than any other rotary positive blower. Capacities of 22 production models range from 50 to 4,000 CFM, pressures to 14 PSIG single, 70 PSIG multi-stage.



For full information write

M-D BLOWERS, INC., RACINE, WISCONSIN

A Subsidiary of Miehle-Goss-Dexter, Inc.

FIRMS . . .

West Coast gypsum producer. Flintkote says that proposed acquisition is part of a program to provide its West Coast customers with a broad line of building materials.

Allied Chemical Corp. and Food Machinery & Chemical Corp. are joining forces for production of carbon bisulfide and carbon tetrachloride. Production facilities are those of FMC's Westvaco Chlor-Alkali Div. at South Charleston, W. Va. Plant, utilizing two original processes, will be expanded in the near future.

Diversey Corp., manufacturer of industrial chemicals and detergents, has acquired a new subsidiary in Italy, making a total of nine affiliates outside the U.S. New firm, called Diversey Italiana, will be headquartered in Milan.

OVERSEAS BRIEFS

Rolls-Royce, Vickers and Foster Wheeler have formed a new British company, Rolls-Royce & Associates, to design and build nuclear power equipment. This move consolidates arrangements already existing between the three firms.

Hungary's output of glass from the reconstructed mill at Zagyvapalfalva is expected to increase from 54 million to 75 million sq. ft. in 1959, allowing export of 16 million sq. ft. The factory was recently equipped with Soviet equipment at a cost of about $6.6 million.

Gulf Italia is building an $18-million petrochemical plant at Ragusa, Sicily, that will produce 10,000 metric tons/yr. of "plastic materials" from crude oil. Start up is scheduled for late this year.

Italy will soon have a new antibiotics plant near Naples. A new company, Fervet-Fer-

mentazioni del Vesuvio Torre Annunziata has been formed for this purpose by Ciba Societe Anonyme of Basel, Switz., and Lepetit, S.p.A., an affiliate of Ledoga of Milan.

NEW LINES

Wolverine Tube Div. of Calumet & Hecla is starting commercial production of columbium metal extrusions. Commercial extrusion process was developed by Wolverine engineers working with the Wah Chang Corp., Albany, Ore.

Union Carbide, long a producer of such metals as calcium, titanium, vanadium, tantalum and columbium, is planning to turn out chemical derivatives of these and other metals. New product line includes anhydrous metal chlorides and oxychlorides used as intermediates for making other metal derivatives.

Dow Chemical has started production of polyethylene film for agricultural uses. Trademarked "Polyfilm," product will be produced by Extruders, Inc., a Dow subsidiary located in Hawthorne, Calif.

NEW LOCATIONS

Dow Chemical is establishing a textile fibers sales center in Charlotte, N. C. Located in the Wachovia Bank Building, office serves nine southern seaboard states from North Carolina to Texas.

Tetrafluor, Inc., has moved into a new plant at 343 Hindry Ave., Inglewood 1, Calif., specially designed for the manufacture of fluorocarbon products.

NEW plastic testing device

Determines temperature at which deflection and penetration occur in thermoplastics.

Operates up to 260°C.

This easy-to-operate apparatus indicates the deflection of thermoplastics subjected to various loads and temperatures in accordance with ASTM Test D648. Four samples may be tested simultaneously by placing each in a specimen holder and lowering it into the insulated bath. Deflections are indicated on dials mounted on the specimen holders. (See photo of enlarged specimen holder)

Bath temperature can be increased at the rate of 2°C per min. from ambient to 260°C, or maintained constant at any point within this range.

10-270 Plastic Deflection Tester consists of the bath, four specimen holders, four thermometers and one loading stand which supports specimen holders when not in use. Operates on 230 volts, 60 cycles, single phase a.c.

Dimensions: 26 x 16½ x 23 in. high.....$1125

Vicat Kit modifies the Plastic Deflection Tester to perform Vicat softening-point tests of polyethylene or other plastic samples. So modified, the tester applies heat to the sample at the rate of 5/6°C per min. until a flat-ended needle penetrates the specimen to a depth of 1 mm under a load of 1000 grams. Kit includes the following:

10-206 Spool & Adapter $25

10-207 Penetration Assembly $55

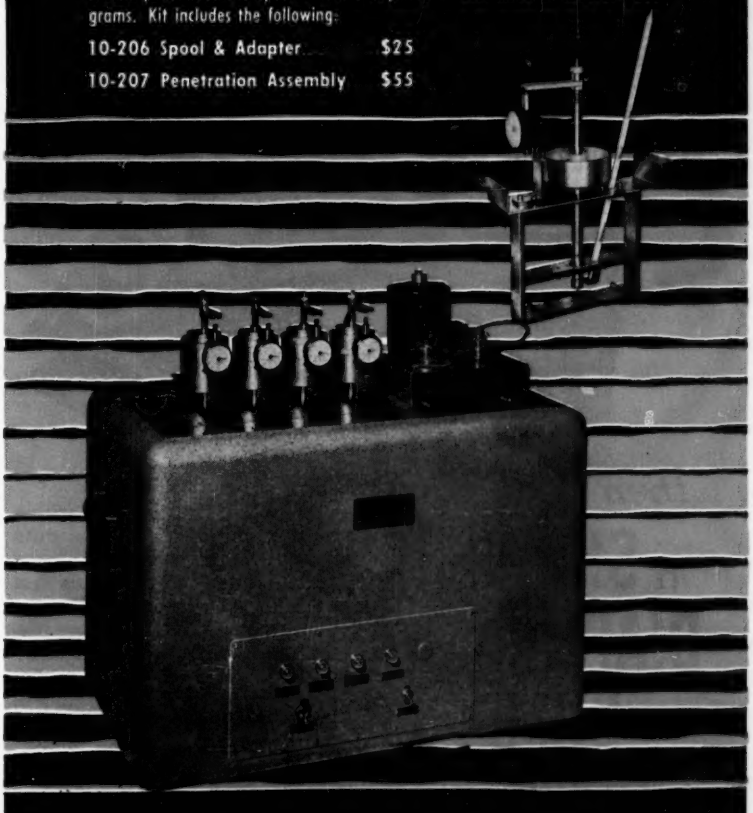


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FIGURE the filter area and capacity required for your process and the size of filter press needed.

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SELECT the filter press design and type best suited to your needs.

Is the fluid
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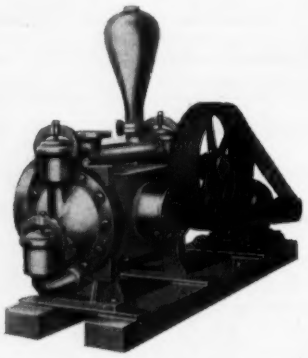
Abrasive
Viscous
Delicate
Thick



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Here's the time-tested positive displacement pump that cuts operating and maintenance costs in handling materials that quickly wear out ordinary pumps. It's a double-acting piston pump without packings; no leakage; easy to clean and service; low power cost; capable of discharge pressures to 100 psi. Bulletin 137A gives the facts.

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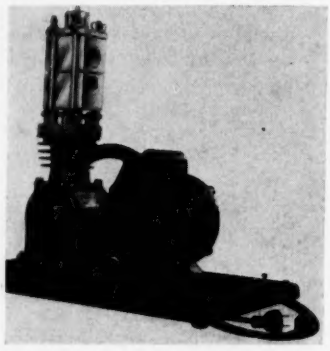
SLAB FORMERS • DIAPHRAGM PUMPS • ELECTROLYTIC CELLS

NEW EQUIPMENT . . .

(*Continued from p.* 116)

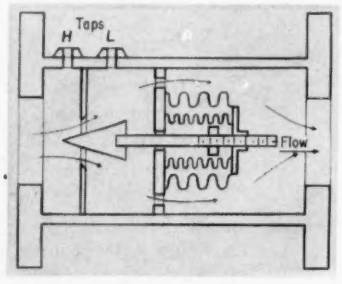


Metering Pump

Injects liquids from low- to high-pressure lines.

Capable of incremental injection at a variable rate, a new positive-displacement ram pump can handle slurries, pastes and greases as well as clear liquids. According to the manufacturer, the unit possesses essentially linear characteristics that enable it to be used in metering applications. Several capacity ranges are offered.

In operation, the entire contents of the cylinder feed into the higher-pressure pipeline or vessel under a wide variety of timing characteristics. Thus, the unit is more appropriate for metered slug rather than continuous feeding.—**Sigmamotor, Inc., Middleport, N. Y. 210A**



Mass Flowmeter

Pressure drop proportional to mass flow.

A new primary element for directly measuring the mass flow of gases utilizes a variable-area orifice to compensate for changes in gas temperature and pressure. Orifice area is a func-

tion of the position of a tapered plug attached to a sealed bellows containing a sample of the gas being measured.

Since the gas within the bellows assumes line temperature, plug position is determined by the temperature and pressure of the flowing gas. Plug shape matches the bellows' characteristics in such a way that orifice area is inversely proportional to the square root of gas density. Thus, the square root of differential pressure across the orifice is proportional to mass flow.

Element material of construction is stainless steel for high pressures, phosphor bronze or brass for lower pressures.—**National Instrument Laboratories, Washington, D. C. 210B**

Portable Centrifuge

Designed to enable in-plant process tests.

Prospective customers of The Pfaudler Co. can now rent a portable CNS-150/151 Titan centrifuge for on-stream production tests and pilot runs. Unit capacity is 3,000 to 6,000 gph. Services of a Pfaudler technician are included for setup and initial runs.

CS-150 is a self-cleaning disk-type centrifuge that develops a settling force of 7,800 g's. It finds application in clarification, concentration and extraction operations. The portable unit includes a steel foundation, electric bowl hoist, receiving tank and instrumentation.—**The Pfaudler Co., Rochester, N. Y. 211A**

Silicon Carbide Foam

Insulation material for high temperatures.

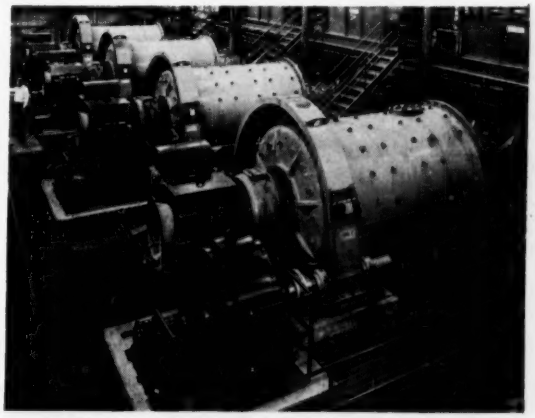
Carborundum Co. will soon be officially unveiling its latest breakthrough in high-temperature materials—foamed silicon carbide. The company is eyeing a future in high-temperature insulation for this new product, citing its 3,000 F. operating temperature.

Since the foam is permeable,

Marcy Grinding Mills

for the Chemical Industry

- center and end peripheral discharge rod mills, open end rod mills, grate discharge ball mills, tube mills, pebble mills, acid-proof mills, batch mills.
- wet or dry grinding.
- 29 different diameter sizes, from 12" to 12'6" inside diameter, are operating and proved in the field.
- grind material 1½" or finer to a product as fine as 325 mesh.
- capacities up to 6650 tons per 24 hours.



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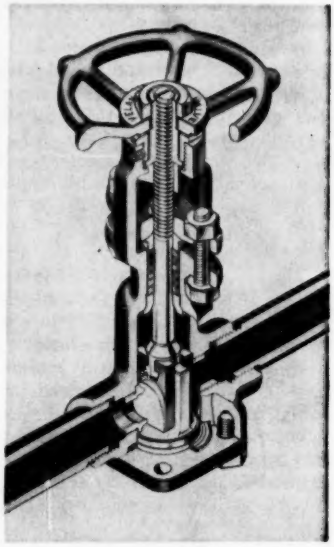
it must be coated with a thin layer of dense, self-bonding silicon carbide for most applications. This layer blocks gas flow through the insulator, and imparts high erosion resistance.

Foamed silicon carbide is readily machined with standard steel cutting tools, thus permitting production of complex shapes. Use of the foam for erosion-resistant rocket nozzles having high thermal shock resistance and low thermal conductivity is already in the talking stage.

Physical properties include: density, 0.25 —0.55 g./cc.; thermal conductivity (low density form), 8 Btu./(hr.) (sq. ft.) (°F./in.); compressive loading (low density), 75-100 psi. — **The Carborundum Co., Niagara Falls, N. Y.** **211B**



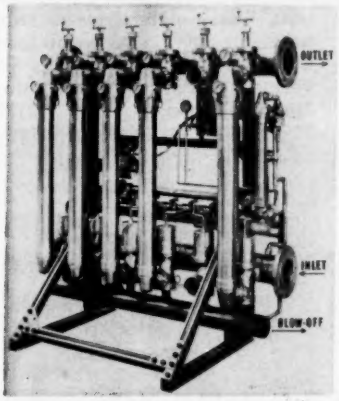
Bonnetless Gate Valve

Permits fast servicing on line; cuts leakage.

A new forged-steel gate valve, claimed by the manufacturer to be of revolutionary design, features a one-piece body that eliminates body-bonnet leakage problems. And, removal of the valve's bottom guide cover enables quick, easy replacement of the unit's wedge, stem and seats. The company also claims that valve design

will provide more positive closing and longer life.

Available in sizes up to 2 in., the bonnetless valves come with any trim for either 600- or 1,500-psi. service.—**Velan Valve Corp., Plattsburgh, N. Y.** 212A



Water Filter

Operates on "dirt" cycle rather than time cycle.

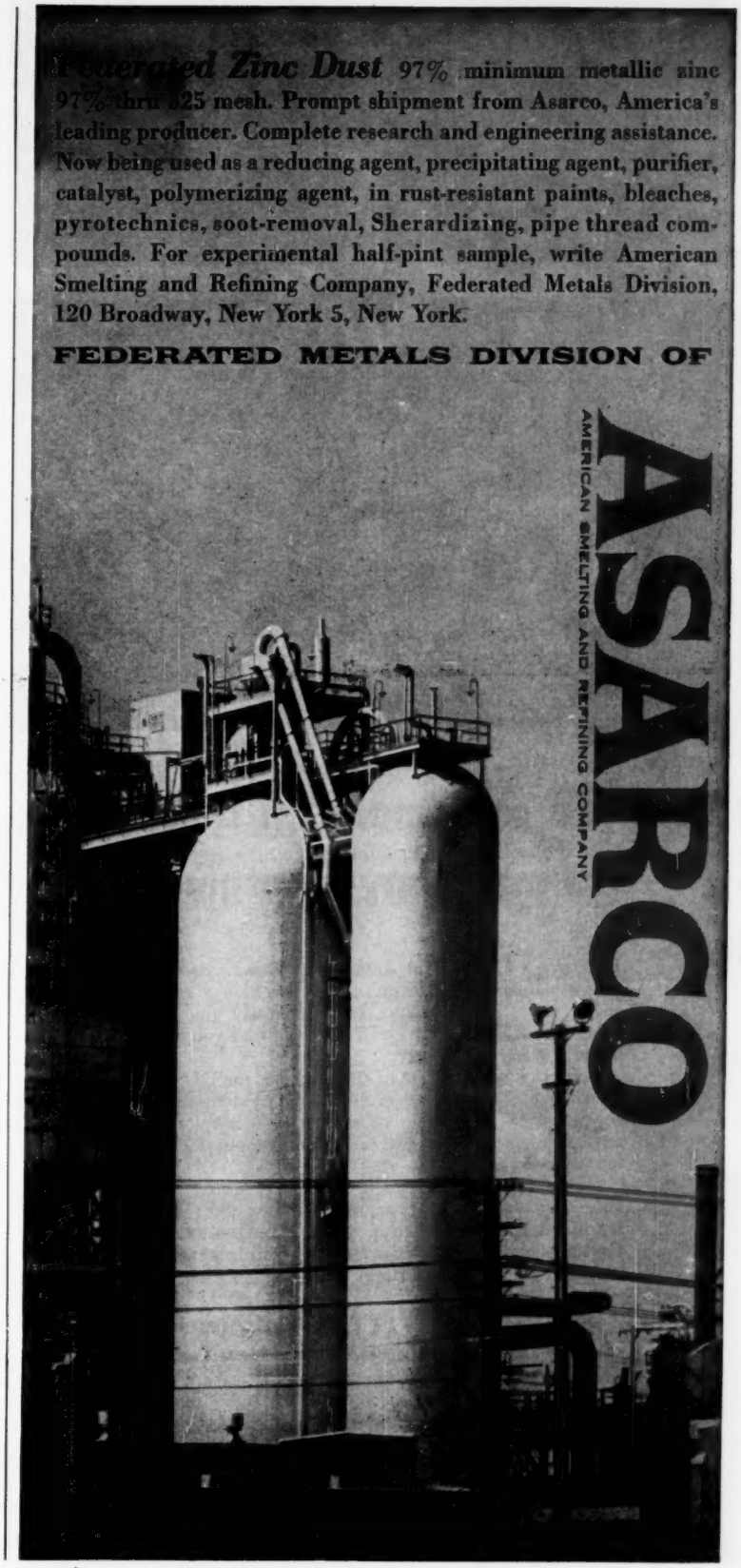
Differential line pressure between incoming and outgoing water automatically controls the backwashing action of the new Ronningen water filter. Another feature is a plurality of individual filters on inlet, outlet and blowoff headers, each with quick couplings. Thus, removal of any filter from the line will not affect operation of the main unit.

Construction is of bronze and copper, with either Monel or 316 stainless steel filter elements. Mesh size varies from 20 to 700, pressure to 200 psi. and temperature to 200 F. Maximum capacity is 1,000 gpm.—**Ronningen-Petter Co., Vicksburg, Mich.** 213A

Portable Spectrograph

For in-process control of plant operations.

Developed specifically for use around industrial plants and in the field, a new portable X-ray spectrograph can analyze powders, liquids, viscous materials and solids. With a standard lithium fluoride crystal, the in-


Federated Zinc Dust 97% minimum metallic zinc
97% thru 325 mesh. Prompt shipment from Asarco, America's leading producer. Complete research and engineering assistance. Now being used as a reducing agent, precipitating agent, purifier, catalyst, polymerizing agent, in rust-resistant paints, bleaches, pyrotechnics, soot-removal, Sherardizing, pipe thread compounds. For experimental half-pint sample, write American Smelting and Refining Company, Federated Metals Division, 120 Broadway, New York 5, New York.
FEDERATED METALS DIVISION OF
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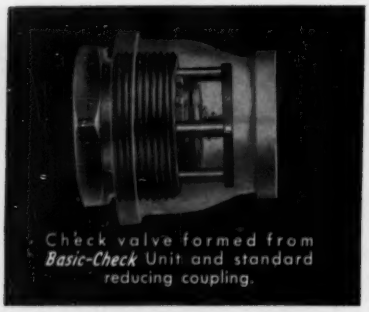
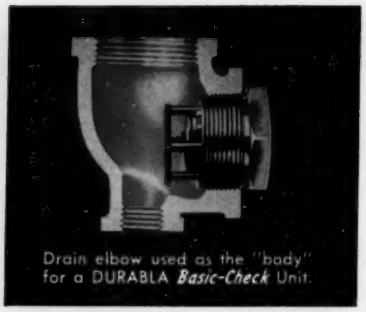
AMERICAN SMELTING AND REFINING COMPANY



Check valve formed from *Basic-Check* Unit and standard reducing coupling.



Drain elbow used as the "body" for a DURABLA *Basic-Check* Unit.

Basic-Check Unit used with a standard side inlet.

Basic-Check Unit at inlet end of this bend completes the check valve.

How you can "make" a check valve to meet any emergency

Just take a DURABLA *Basic-Check* Unit . . . combine it with a standard pipe fitting . . . and you have a complete check valve that's perfect for practically any service. Keep a few *Basic-Check* Units on hand and you are prepared for any emergency.

Because it will operate in any position, the DURABLA *Basic-Check* Unit can be installed without changing existing lines. Made of stainless steel, they'll handle almost any liquid, gas or air . . . over a broad range of pressure-temperature ratings.

DURABLA *Basic-Check* Units are versatile, dependable, efficient and inexpensive. They come in seven standard line sizes, from ⅜" to 2". Also available: DURABLA Reducing Couplings of stainless steel.

Ask for a copy of Bulletin CE 39

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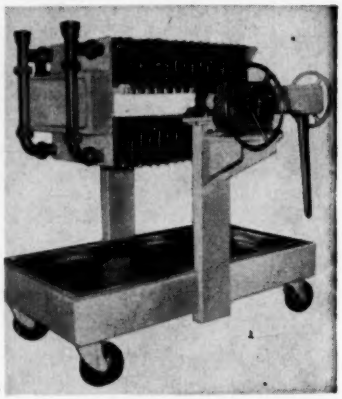
DURABLA®

DM-32

strument covers the elements having atomic numbers from 22 to 50 in the K series and 57 to 92 in the L series.

Each unit consists of an 18-lb. detector head and a 48-lb. power supply/electronic chassis. Area of manipulation of detector head is limited only by the length of cables between head and power unit. The system operates from a 115- or 230-v. source, or from a 6- or 12-v. battery plus inverter. — **Philips Electronics, Mount Vernon, N. Y.** **213B**



Filter Press

Loads in horizontal position; operates vertical.

Filter cake will not fall away from plates of the new Terriss filter press, even with a pressure drop to zero. This is possible because the unit operates in a vertical position. For cleaning and loading, the unit turns about a worm gear to the horizontal position.

Number of plates can vary from 2 to 35, providing from 15 to 100 sq. ft. of filtration area; cake thickness runs 1½-3 in. Media supports and screen backing plates are stainless steel. Prices begin at $1,500.—**Consolidated Siphon Supply Co., Inc., New York, N. Y.** **214A**

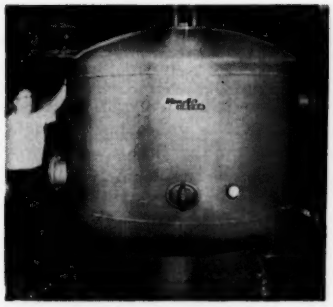
Regulator

Has heating jacket that is bonded to surface.

Sliding-gate regulators equipped with Thermon jackets are now available in sizes from

¼ to 6 in. Claimed to be more efficient than conventional tracing and less expensive than steam packeting, Thermon jackets permit regulator use with viscous, high-freezing-point and other hard-to-handle fluids.

Maximum working pressure is 250 psi., maximum temperature is 406 F. Thermon jacketing is removable.—**OPW Jordan, Cincinnati, Ohio. 214B**



Compressed-Air Dryer

Removes moisture and suspended particles.

Compressed-air dryers with capacities to 30,000 cfm. are offered as a means of protecting critical instrumentation and process equipment against damage by moisture and micronic particles.

All models incorporate a triple-action desiccator designed to operate without regulation, carry-over or appreciable pressure drop. There are no heating or desiccant-regeneration requirements—the desiccant is deliquescent.—**Van Products Co., Erie, Pa. 215A**

BRIEFS

Gate valves made of Types 316 and J-20 alloys are offered in ½- to 8-in. sizes for 150-lb. flanged-end valves; size range for 200-lb. screwed-end units is ¼ to 2 in. All models come fitted with a split wedge of ball-and-socket design.—**Jenkins Bros., N. Y., N. Y. 215B**

Split-body valves for control applications at high temperatures and pressures feature

a direct approach
to your filtration problem
SPERRY
Sperry Filter Presses can be made with new glass-reinforced Polyester plates and frames.

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Through 90 years of filtration leadership, Sperry has solved thousands of filtration problems for hundreds of industries—continually applying new ideas—new techniques—and new engineering know-how to produce *flexible, superior filtration at low cost!*

Sperry makes this priceless experience available to all industries—everywhere! To introduce it to your plant, simply write for a copy of Sperry's comprehensive filtration catalog. It's yours, without cost or obligation.

SPERRY

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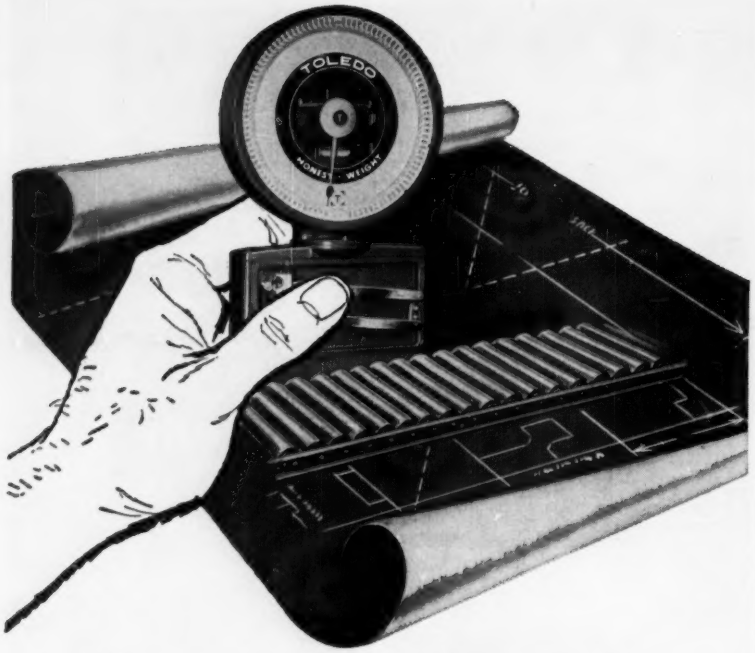
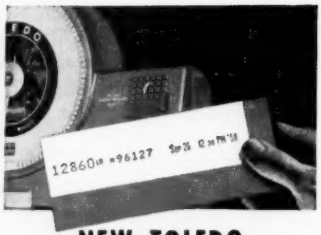


the cost-saving trend today puts BETTER CONTROL where it counts most!

On industry's scales, materials become money. Weight records directly affect costs, quality, inventories and customer billing. That's why it is so vitally important to put *Toledos* at all weighing points . . . where control counts most!

Major advantages that are yours with Toledos are being proven daily in plants of every size. Toledos provide more complete cost data . . . greater selection of models . . . savings in time and materials . . . welcome new simplification of records and record keeping. You can even carry Toledo accuracy directly into your accounting and inventory records, through weights printed at the scale, or transmitted on "electronic wings" for remote recording.

There are specialized Toledo units, too, for classifying, testing, counting, automatic batching and bulk weight control. So, whatever your weighing need, you need Toledos. To help you evaluate weighing efficiency in your plant, send for the Toledo weighing analysis kit. No obligation. TOLEDO SCALE, Division of Toledo Scale Corporation, Toledo 12, Ohio.



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Greatest Name in Weighing

large flow capacities, face-to-face dimensions based on ISA standards and interchangeability of parts.—**Kieley & Mueller, Inc., Middletown, N. Y.** 215C

Thermostat for 32 to 500 F has been approved for Class 1, Group D hazardous areas. Unit is designed for tank immersion or wall installation. Current rating is 10 a. at 115 v. a. c. or 5 a., 230 v.—**Fenwal Inc., Ashland, Mass.** 216A

Ductile iron pipe, tubing and fittings are now available in commercial quantities from the manufacturer. Developed only a few years ago, ductile iron combines the corrosion resistance of cast iron with the mechanical properties of steel.—**American Cast Iron Pipe, Birmingham, Ala.** 216B

Plastic floor compound known as Metacrete resists abrasion and chemicals that ruin wood, metal and concrete surfaces, according to the manufacturer. Coating cost varies from 75¢ to $1/sq. ft., including labor.—**American Metaseal Corp., West New York, N. J.** 216C

Packaging bag for explosives consists of an outer multi-ply layer of creped kraft paper, and a seamless, pinhole-free polyethylene liner. Liner safely heat-seals to provide the necessary waterproof enclosure.—**Bemis Bro. Bag Co., St. Louis, Mo.** 216D

Automatic tank gages for 5- to 15-ft.-dia. storage vessels operating at atmospheric pressure come with either vertical or horizontal reading dials. New design uses a direct positive linkage between float and dial.—**Vapor Recovery Systems Co., Compton, Calif.** 216E

Pipe fittings made of malleable ductile iron have precision threads that are climed to eliminate "leakers." Available size range covers ⅛ in.-27 through 2 in.-11½ in zinc finish or galvanized finish plated with Brass Dichrom-

ate.—**Pipe Fittings Inc., Wellington, Ohio.** 216F

Detector shows the presence of 0.5 to 10 ppm. of unsymmetrical-dimethyl hydrazine. An aspirator draws air through treated filter paper to produce a colored spot, which is matched with a calibration chart.—**Mine Safety Appliances Co., Pittsburgh, Pa.** 217A

Vacuum gage accurately measures pressures of 10^{-10}mm. Hg, and permits direct readings down to 10^{-12}mm. Hg. Designated Model 2205-01, the unit is a modified ionization gage.—**NRC Equipment Corp., Newton, Mass.** 217B

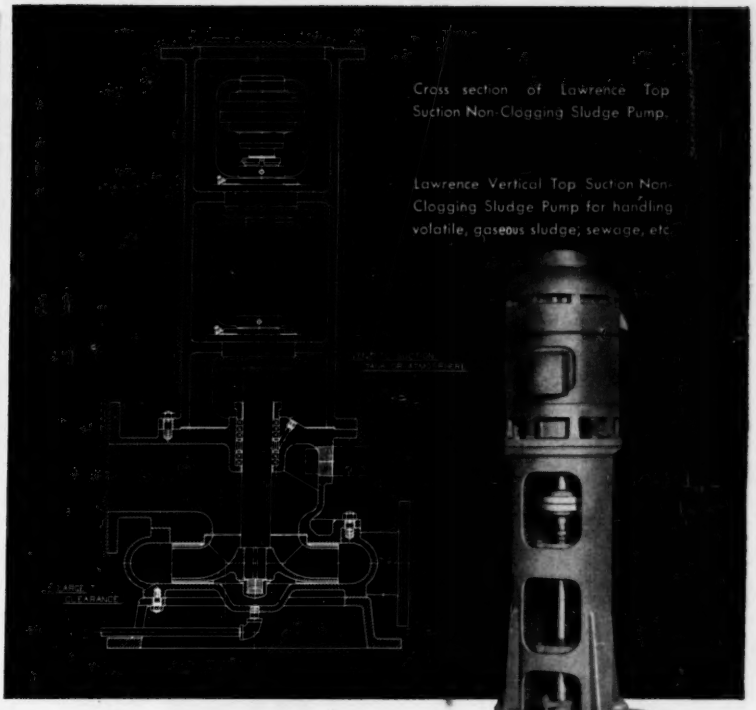
Power units known as the G-149 and G-226 develop 45 bhp. at 2,000 rpm. and 67 bhp. at 1,800 rpm., respectively. Both gasoline-fueled units have a heavy-duty Twin-Disc clutch power take-off and a large-diameter flywheel. Magneto ignition is standard equipment. — **Allis-Chalmers Mfg. Co., Milwaukee, Wis.** 217C

Vacuum evaporator for low-temperature processing is fabricated entirely from stainless steel. Easy to clean and operate, the Tower-Anhydro requires a minimum of space.—**Tower Iron Works, Inc., Providence, R. I.** 217D

Drum heater constructed of aluminum provides controlled, uniform heat at temperatures up to 550 F. Consisting of a roll-away base, cylinder and insulated cover, the unit completely encloses drums.—**Glas-Col Apparatus Co., Terre Haute, Ind.** 217E

Screening feeder for efficient rate-controlled simultaneous screening and feeding of dry bulk materials features fingertip control of vibration power. Operating rate is 3,600 vibrations/min. — **Syntron Co., Homer City, Pa.** 217F

Digital micrometer automatically scans and prints data from one to 99 gaging points


Cross section of Lawrence Top Suction Non-Clogging Sludge Pump.
Lawrence Vertical Top Suction Non-Clogging Sludge Pump for handling volatile, gaseous sludge, sewage, etc.

PUMP
volatile
SLUDGES AND SLURRIES

...without clogging
...under a low net positive suction head (NPSH)
...without gas or vapor binding

The Lawrence Non-Clogging Top Suction Pump is designed specifically to handle volatile sludges and slurries. Large clearances through the impeller and casing completely prevent clogging. Volatile gases or vapors liberated at the impeller entrance (the point of lowest pressure), are pushed up and out of the way and can be vented back to the suction tank or exhausted to atmosphere.

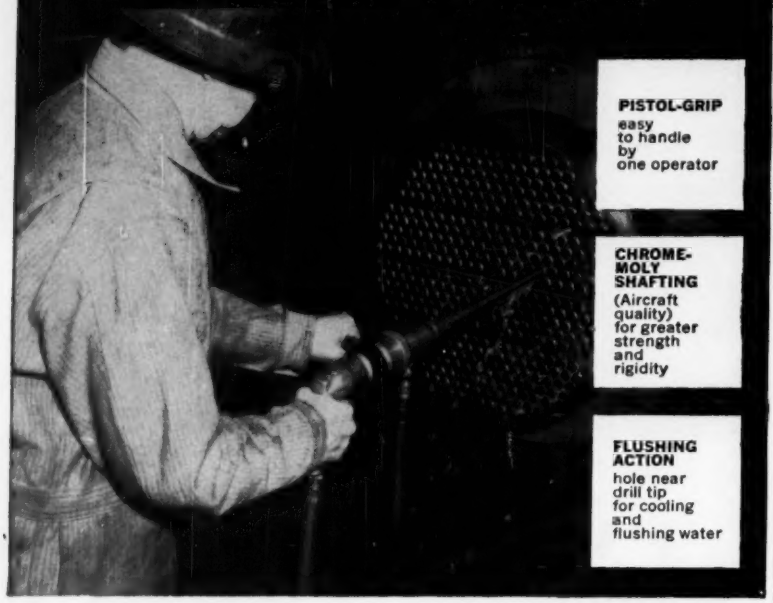
This type of pump can operate with a very low Net Positive Suction Head (NPSH) and never become gas or vapor bound. It is made in all metals and alloys such as: — cast iron, bronze, stainless steel, Hasteloy, etc. — depending on the material pumped.

For further details on Lawrence Non-Clogging Slurry and Sludge Pumps write for Bulletin 206-4.

LAWRENCE PUMPS INC.
357 Market Street, Lawrence, Mass.

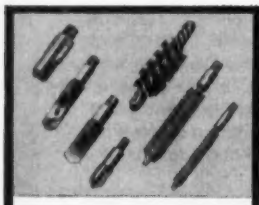
newest ELLIOTT tube cleaner

lightweight! air-driven!

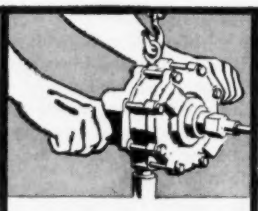

PISTOL-GRIP
easy to handle by one operator
CHROME-MOLY SHAFTING
(Aircraft quality) for greater strength and rigidity
FLUSHING ACTION
hole near drill tip for cooling and flushing water

for condenser and heat exchanger tubes

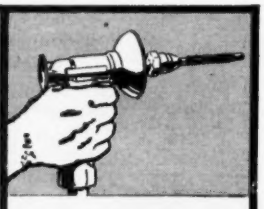
Lightweight. Powerful. Air-driven. Trigger-action control with speed governor to prevent shaft-whip. High-speed motor reduced through planetary gears to 1500 rpm. Integral water-feeding attachment with finger-action valve which controls flow of cooling water into hollow shaft and drill or brush. Built-in oil reservoir. Send for tube cleaner bulletin Y-48.



DRILLS AND BRUSHES FOR VARIED NEEDS
Brushes for light deposits. Four types of drills clean light, hard-heavy, hard-light, and gummy deposits.



SUSPENSION TYPE
Air, steam or electric heavy-duty motor, for removing hard, heavy deposits. Ball bearings absorb thrust in either direction.



ELLIOTT JIFFY GUN
For extra-fast cleaning of light deposits in tubes ½ in. to 1¼ in. Air or water pressure shoots nylon brushes or rubber plugs through tubes.

ELLIOTT Company
Lagonda Plant—Springfield, Ohio

Y9-1

NEW EQUIPMENT . . .

with accuracy to 0.0001 in. Operation can be manual, semiautomatic or synchronized with manufacturing and inspection processes.—**Daytronic Corp., Dayton, Ohio.** 217G

Pump case for Verti-Line pumps is claimed to be tougher and longer lasting. Standard case Mo content is 0.35%. For tensile strengths to 50,000 psi., cases are offered with up to 2% Mo.—**Layne & Bowler Pump Co., Los Angeles, Calif.** 218A

Flexible hose made of Viton synthetic rubber is useful for short periods at temperatures to 600 F., lasts indefinitely at 350 F., and resists extremes of chemical attack. Having a jacket of Dacron fibers, the hose comes with 1- to 4-in. inside diameter.—**H. K. Porter Co., Inc., Philadelphia, Pa.** 218B

Equipment Cost Indexes . . .

	Sept. 1958	Dec. 1958
Industry		
Avg of all.....	230.9	231.3
Process Industries		
Cement mfg.	223.3	223.7
Chemical	232.3	232.7
Clay products	217.0	217.4
Glass mfg.	219.3	219.7
Paint mfg.	222.8	223.1
Paper mfg.	223.8	224.2
Petroleum ind.	227.5	227.8
Rubber ind.	230.3	230.6
Process ind. avg..	228.6	228.8
Related Industries		
Elec. power equip. ..	236.0	236.4
Mining, milling	233.7	234.1
Refrigerating	260.3	260.6
Steam power	218.1	218.4

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago for 47 different industries. See Chem. Eng., Nov. 1947, pp. 125—6 for method of obtaining index numbers; Feb. 24, 1958, pp. 143—4 for annual averages since 1913.

For More Information . . .
about any item in this department, circle its code number on the
Reader Service
postcard (p. 227)

CALENDAR

American Society of Mechanical Engineers, Instruments and Regulators Division Conference, Case Institute of Technology.
March 29-April 2 Cleveland, Ohio

American Physical Society, annual meeting.
March 30-April 2 Cambridge, Mass.

American Power Conference, Hotel Sherman.
March 31-April 2 ....Chicago, Ill.

American Institute of Chemical Engineers, Philadelphia-Wilmington Section, Symposium: Experience in Industry, University of Penn.
March 31 Philadelphia, Pa.

Pharmaceutical Manufacturers Assn., annual meeting, Boca Raton Club.
April 1-3 Boca Raton, Fla.

American Institute of Mining, Metallurgical and Petroleum Engineers, Technical Conference: Stress Corrosion, Mellon Institute.
April 2-3 Pittsburgh, Pa.

American Chemical Society, annual national meeting.
April 5-10 Boston, Mass.

Nuclear Congress, coordinated by the Engineers Joint Council, Public Auditorium.
April 5-10 Cleveland, Ohio

Instrument Society of America, Second National Symposium on Chemical and Petroleum Instrumentation.
April 6-7 St. Louis, Mo.

American Institute of Mining, Metallurgical and Petroleum Engineers, 42nd national Open Hearth Steel Conference and Raw Material Conference, Jefferson Hotel.
April 6-8 St. Louis, Mo.

American Institute of Chemical Engineers, Ohio, Pittsburgh and West Virginia Sections, annual symposium: Catalysis, Mellon Institute.
April 10 Pittsburgh, Pa.

National Petroleum Assn., semi-annual meeting, Hotel Cleveland.
April 15-17 Cleveland, Ohio

Engineering, Marine Welding and Nuclear Energy Exhibition.
April 16-30 Olympia, England

American Oil Chemists Society, 50th Anniversary Meeting, Roosevelt Hotel.
April 20-22 New Orleans, La.

National Gasoline Assn., of America, 38th annual convention, Baker and Adolphus Hotels.
April 22-24 Dallas, Texas

13th Annual Power Sources Conference, Shelburne Hotel.
April 28-30 Atlantic City, N. J.

Electrochemical Society, 115th national meeting, Sheraton Hotel.
May 3-7 Philadelphia, Pa.

American Institute of Chemists, annual meeting, Hotel Traymore.
May 6-8 Atlantic City, N. J.

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When foam moves *in*, efficiency moves *out* . . . production goes down! Costs go up! If foam is hogging space in your plant, knock it down with Dow Corning SILICONE DEFOAMERS . . . most versatile and effective foam killers made!

1 oz kills foam in:

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125,000 lb asphalt
62,500 lb hypo fix and film developer

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NAME

TITLE

COMPANY

CITY ZONE STATE

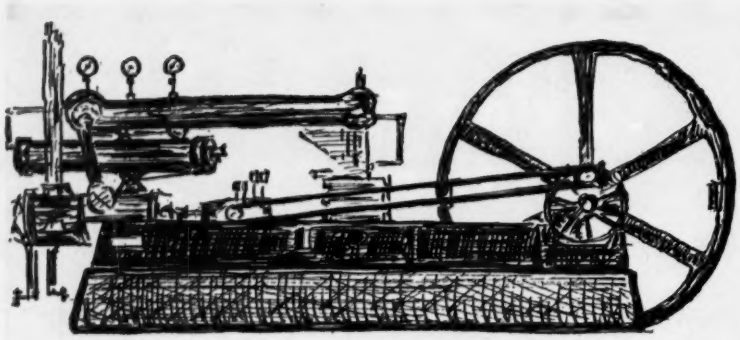
My foamer is

Oil system

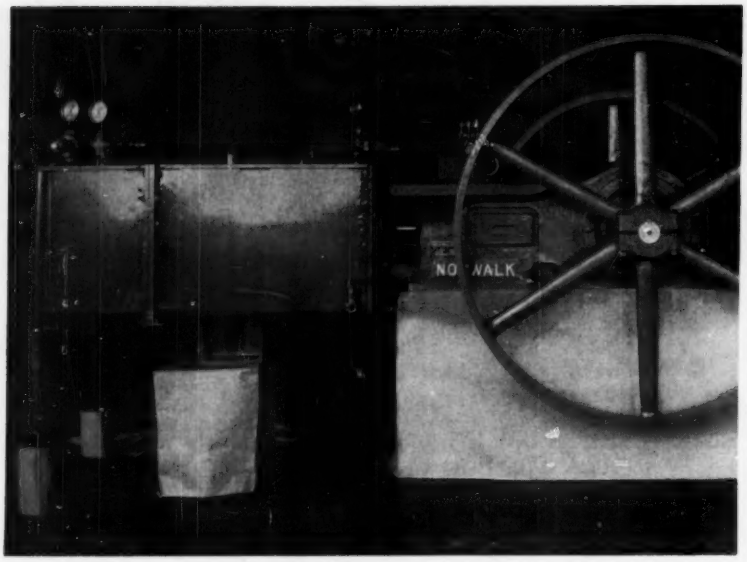
Aqueous system

Food products

Other



This Norwalk compressor, installed in 1908, in an acetylene manufacturing plant in the midwest, is still in operation.



Factory view of current 3-stage acetylene compressor, as manufactured by Norwalk Company.

Every Norwalk compressor is test-run at the factory, then taken down for complete inspection before re-assembly and shipment. Norwalk makes compressors from single stage to six stages, from 125 to 25,000 psi pressure, for gases listed below:

ACETYLENE	HCL
AIR	HELIUM
ARGON	HYDROGEN
CERTAIN HYDRO CARBONS	NITROGEN
CO and CO_2	NITROUS OXIDE
ETHANE	OXYGEN
ETHYLENE	

For full details, write for Catalog 44

NORWALK COMPANY, INC.

SOUTH NORWALK, CONNECTICUT

Established 1864

Makers of high pressure compressors since 1864

TECHNICAL

Nuclear Reactor Primer

NUCLEAR REACTORS FOR POWER GENERATION. Edited by E. Openshaw Taylor. Philosophical Library, New York, N. Y. 144 Pages. $7.50.

This little volume is an excellent primer for the engineer interested in learning basics in nuclear reactor technology; it presents a fairly complete, reasonably up-to-date summary of reactor types, materials used therein, and the present economics picture.

It does not burden its non-reactor-designer reader with complex details or formulas; yet it is not an insult to the technical mind, as so many nuclear primers are.—JAK

The Tone Is Research

EFFECTS OF RADIATION ON MATERIALS. Edited by J. J. Harwood, Henry Hausner, J. G. Morse, and W. G. Morse. Reinhold Publishing Corp., New York. 355 Pages. $10.50.

More and more engineers today are concerned with radioactive conditions and their effects on materials. In fact a colloquium, "The Effects of Radiation on Materials," was presented in March, 1957, at Johns Hopkins University to review the unclassified material in this field.

A hard-bound volume, with the same name as the colloquium, is now available embodying a collection of papers presented there. Authorities on materials from the Martin Co. and U. S. Naval Research Office have edited the book.

▸ **Emphasis on Research**—Quite properly, it begins with a chapter on present theories of why and how radiation affects materials, and here leans toward the interest of the physicist.

Chapters that follow are on research; they report methods of radiation study and results of physical and metallurgical test-

BOOKSHELF

J. B. BACON

ing of irradiated metals, alloys, dielectric materials and semiconductors.

Materials used in nuclear reactors, such as coolants, control rods, moderators and shielding, are adequately treated in two chapters that will be of interest primarily to the engineer working in the nuclear field.

In fact, he's the engineer who will be most interested in this volume both as a reference and as informational-pastime reading material. The exception might be the man interested in radioactive effects on polymerization.

Several chapters are concerned with radiation processing; one on graft polymerization is particularly interesting. General tone throughout the book is researchy, probably because the field is young and for the most part related engineering work is restricted to research.—JAK

BRIEFLY NOTED

CATALOG OF PUBLICATIONS, 1959. *60 pp. American Petroleum Institute, Publications Dept., 50 W. 50 St., New York 20, N. Y.* Free. Contains thumbnail descriptions of each publication, code numbers and costs and specific instructions for ordering items.

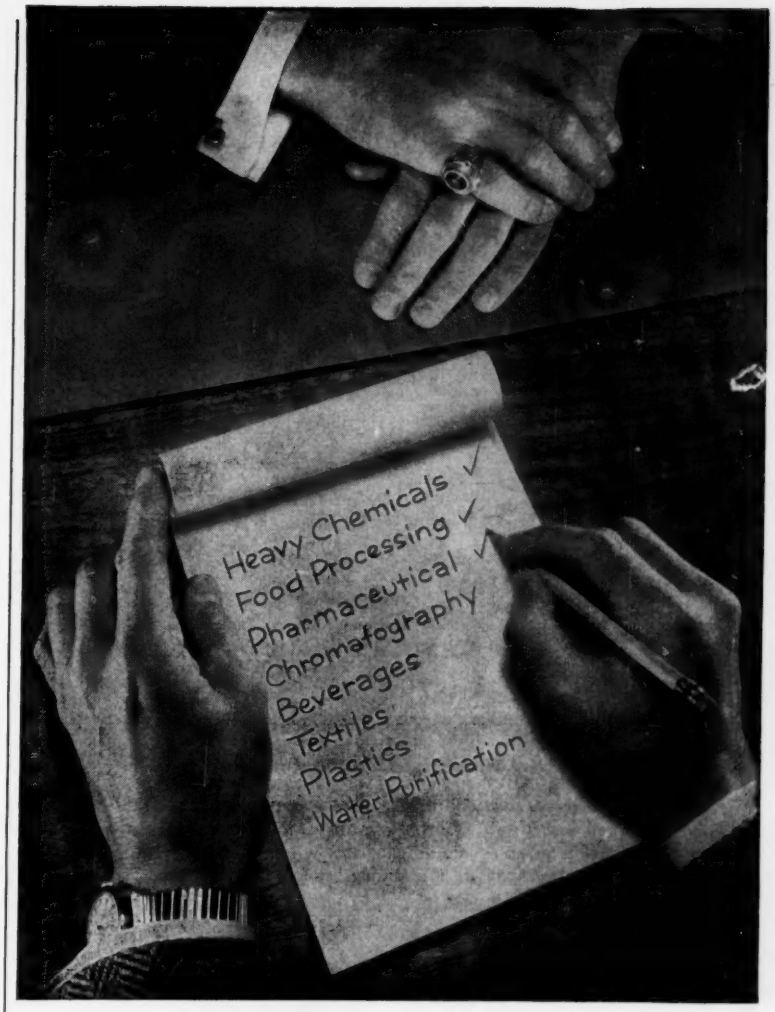
FLOW PROPERTIES OF BULK SOLIDS. *51 pp. By A. W. Jenike, P. J. Elsey and R. H. Woolley. Utah Engineering Experiment Station, 207 Mines Bldg., University of Utah, Salt Lake City 12, Utah.* $1.50. Presents results of tests in a form applicable to the design of storage plants.

MORE NEW BOOKS

COLORIMETRIC DETERMINATION OF TRACES OF METALS. By E. B. Sandell. Interscience. $24.

HEAT AND MASS TRANSFER, 2nd ed. By Eckert and Drake. McGraw-Hill. $12.50.

ANALYSES OF INDUSTRIAL OPERATIONS. Edited by Edward H. Bowman and Robert B. Fetter. Irwin. $9.55.



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Let us give you the facts on this versatile filter aid. Whether your field is heavy chemicals, food processing, pharmaceuticals, chromatography, beverages, textiles, plastics, water purification, stream pollution or a long list of others, it can benefit you.

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NEROFIL

The Carbon-Based Filteraid for Caustic, Acid, Sulphur and Other Difficult Filtrations such as Fluorated Solutions.

NEROFIL, available in 6 grades to meet all needs for high clarity and fast flow-rate, is produced and sold by the Great Lakes Carbon Corp. whose Dicalite Dept. long has been a leader in the filtration industry.

Check these NEROFIL Advantages!

Not just crushed carbon, but a genuine filteraid specially processed for greater porosity and maximum surface area, NEROFIL is giving excellent results where no other filteraid had ever been entirely satisfactory.

FLOWRATES and CLARITY comparable to many grades of diatomite filteraids.

FILTERAID SAVINGS UP TO 20% because of Nerofil's lower cake density and high porosity.

READILY WETTABLE in either aqueous or non-aqueous solutions.

PHYSICALLY AND CHEMICALLY STABLE – Nerofil is unaffected by either acids or alkalis – tests show no silicon solubility in 50% sodium hydroxide at 125°F in 30 minutes.

FILTERCAKE IS COMBUSTIBLE, with a fuel value of 13,000 BTU per pound. Metals values recovery is thus easy, and disposal is no problem.

Excellent for Filler use, too

TREMENDOUS SURFACE AREA of Nerofil, plus its other properties, give it definite advantages as a filler in resins, cements, etc., as a catalyst carrier, in foundry applications and other uses.

USE COUPON FOR FREE ILLUSTRATED BULLETIN

NERO PRODUCTS DEPT., Great Lakes Carbon Corporation
333 No. Michigan Ave., Chicago 1, Ill.

Yes, I'd like information on Nerofil for ☐ *Filtration* ☐ *Other Use*

Name_____ Position_____

Company_____

Address_____ City_____ Zone____ State_____

LETTERS:

Products Beat Specs

Sir:

The play given our Udex process in your Jan. 12 issue (Process Flowsheet, pp. 110-113) is very nice indeed.

We were at first misled, while reading this story, into believing that the *specifications* you listed in the tabulation were in fact product *inspections*. We sincerely hope that none of your readers will be similarly misled. The acid-wash colors were particularly disturbing, because much better values are being obtained than the listed specifications; less than 1 is the rule, I am told.

D. P. THORNTON, JR.
Universal Oil Products Co.
Des Plaines, Ill.

▶ *We apologize for any confusion arising from our presentation of data. The table was headed "Products above nitration-grade purity," while the data in the table were the nitration-grade specifications.*—ED.

Process of Elimination

Sir:

We are a little puzzled by the gratuitous statement in your Jan. 26 *Chementator* (p. 42) which reads: "First Stora-Vulcan installation in the U. S. was at an unnamed urea plant (presumed by trade sources to be Sohio at Lima, Ohio)."

Sohio has never used the Stora-Vulcan evaporator. The first U. S. installation was in a urea plant for another customer whose identity we are not at liberty to divulge.

CLARENCE MITCHELL
Vulcan-Cincinnati, Inc.
Cincinnati, Ohio

Temperature Corrections

Sir:

Your article, "First Nonaqueous Recovery of Fuel Completed" (Feb. 9, pp. 68-70), was extremely well written. Your staff did an excellent job in condensing and presenting the information contained in my AIChE paper.

PRO & CON

C. H. CHILTON

I have noticed two minor errors. One of these was my failure to specify fluorination temperature (I was unaware of this omission until I saw your article). The 980 F. temperature is the melting point of the salt. Fluorination is actually carried out at about 1,100 F. to insure a completely melted, low-viscosity batch. The other correction is the temperature of the second cold trap; this should be −76 F., rather than −108 F.

W. H. CARR
Oak Ridge National Laboratory
Oak Ridge, Tenn.

Control of Dusts and Fumes

Sir:

In what was a very interesting news item under the heading, "How dusts synergize pollution hazards" (Dec. 29, p. 22), the last paragraph implies that Los Angeles County has not done much about, nor is it concerned with, the control of solids in the form of dusts, fumes and smoke.

We would like to refer you to Rules 50, 52, 53b and 54 of our published Rules and Regulations. You will note the degree of limitation placed on particulate emissions, both as to concentration and allowable limit per hour, as well as the permitted opacity or density.

Because of these rigid restrictions controlling these various types of emissions, we feel proud of the fact that we have consistently narrowed the field of the smog-contributing sources until the big, uncontrolled source —hydrocarbon emissions from fossil fuels—is our major remaining problem.

S. SMITH GRISWOLD
Air Pollution Control District
Los Angeles, Calif.

► *As pointed out previously (Dec. 15, p. 65), the dreaded acid smog has been shown to result only when sulfur dioxide in the atmosphere is catalytically oxidized by certain specific types of particulate matter, such as manganese sulfate and iron sulfate. The authorities are clamping down on emission of sulfur di-*

Tips to help you cut impact socket breakage

- Position power wrench so that socket fits straight on nut. Tilted wrench causes binding and socket breakage.
- Use right size socket . . . replace worn or undersize nuts. Loose-fitting sockets wear faster — then break.
- Don't keep impacting after nut is tightly set. This causes needless wear on both wrench and socket.
- Keep the inside of sockets clean. Dirt and grease are common causes of socket breakage.
- When power wrench drive head becomes worn — replace it. Loose drive causes excess wear in socket drive opening — early socket breakage.

Best tip yet!

ALWAYS USE *Snap-on* INDUSTRIAL SOCKETS

Sockets used on power nut runners and impact wrenches take a terrific pounding. Standard hand-wrench sockets are not designed for this work. *Snap-on* heavy-duty industrial sockets have the extra heft and toughness to take the beating. Result: more work-hours per socket and, equally important, less costly downtime resulting from frequent breakage of ordinary sockets.

Final tip. Talk sockets with your *Snap-on* man. Take advantage of his specialized tool knowledge, and his competent advice on what is best for you in the wide range of *Snap-on* industrial sockets. Your nearby *Snap-on* branch office provides prompt emergency or regular service.

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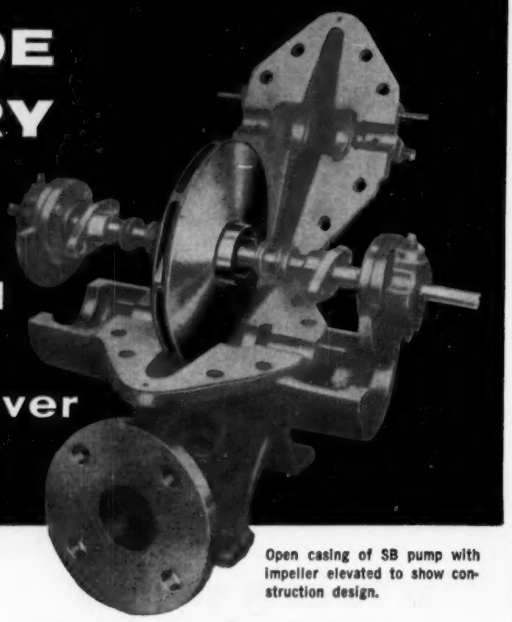
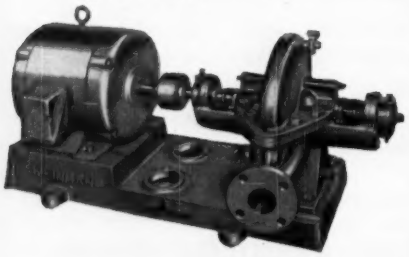


Open casing of SB pump with impeller elevated to show construction design.

The heart of a pump is its impeller. Notice in the photo above the clean, efficient design of the double suction bronze impeller for Weinman Type SB pumps. All external surfaces are carefully machined and finished. Interior surfaces are hand finished. Result: More pumping capacity at economical, wear-saving motor speeds.

Weinman Type SB single stage, double suction, split case centrifugal pumps are designed for ½ to 15 hp motors . . . 1800 to 3600 rpm speeds. They handle a lot of different pumping duties. And maintenance costs are down-to-earth. Upper half of the casing is easily removed for inspection. Entire rotating element comes out without disturbing piping, connections, fittings or driver.



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oxide but have not acted specifically against the emission of these chemically active solid particles.

The rules which Mr. Griswold cites regulate emission of dusts and fumes in general. Actually, one rule not cited (Rule 51) would be more applicable, if enforceable. It reads:

"A person shall not discharge from any source whatsoever such quantities of air contaminants or other material which cause injury, detriment, nuisance or annoyance to any considerable number of persons or to the public or which endanger the comfort, repose, health or safety of any such persons or the public or which cause or have a natural tendency to cause injury or damage to business or property."
—ED.

Tax on Moving Expenses

Sir:

In your Feb. 10, 1958, issue (p. 163) you refer to a Federal District Court ruling concerning taxation on payments for moving expenses.

I would appreciate it if you could tell me the final outcome of the appeal of this decision. I am in the position of having paid such tax recently, and I hope to determine my chances for recovering same.

R. W. DUHL
Vulcan-Cincinnati, Inc.
Cincinnati, Ohio

▶ *Mr. Duhl's chances of recovering any such payment now, unfortunately, are zero.*

Question is whether or not you must report as income, and pay taxes on, money you received from a new employer to reimburse you for moving expenses incurred when you changed jobs. The answer is definitely yes. Here's a quick summary of recent legal maneuvers:

Federal District Court, Albuquerque, first ruled that reimbursement of relocation expense did not constitute compensation and was not taxable income.

On appeal by Internal Revenue Service, this decision was reversed by Tenth Circuit Court of Appeals, Denver, on the grounds that such a payment was in the nature of a cash bonus as an inducement to accept employment. The court emphasized that present laws do not allow the taxpayer to deduct expenses incurred in seeking and obtaining employment or in traveling to the place of employment.

The Circuit Court's decision was reinforced recently when the Su-

preme Court declined to review it.

Meanwhile, Sen. Clinton P. Anderson has tried, unsuccessfully, to push a bill through Congress which would amend the tax laws to exclude from taxable income money received from a new employer as reimbursement for moving expenses. If you agree with Sen. Anderson that the present law is inequitable and should be changed, write to your own congressmen.—ED.

Con: Implied Endorsement

Sir:

I think you should have checked with users before publishing "Where Tail Gas Oxidation Stands Today" in your Jan. 12 issue (pp. 66-70).

After several attempts by the contractor and catalyst suppliers, we still do not have a system which will work as it was supposed to when using natural gas. (I understand, although not specifically confirmed, that these systems do work with hydrogen.) In the meantime, pressure from the surrounding community continues.

Others interested in solving this problem may be placed in an unfavorable position if they assume that all the information in your article is correct.

FRANK W. WILSON
St. Paul Ammonia Products, Inc.
South St. Paul, Minn.

► *We pointed out in our article that this field is "still an art" and that commercial units are operating "with varying degrees of success." The article made no claim that the St. Paul unit was operating successfully.*

As to checking with users, we tried two companies, neither of which would comment on how well their units were working. That's the reason we prominently labeled sections of the article "What Catalyst Makers Report" and "How Engineering Companies Feel." We agree that a similar section reporting comments from users would have been valuable if suitable information on performance had been available.

Maybe the answer to Mr. Wilson's problem lies in a statement in our article attributed to Chemical Construction Corp. Whereas St. Paul is trying to operate on natural gas with a ribbon catalyst, Chemico points out that "with natural gas, a pellet catalyst is called for."—ED.

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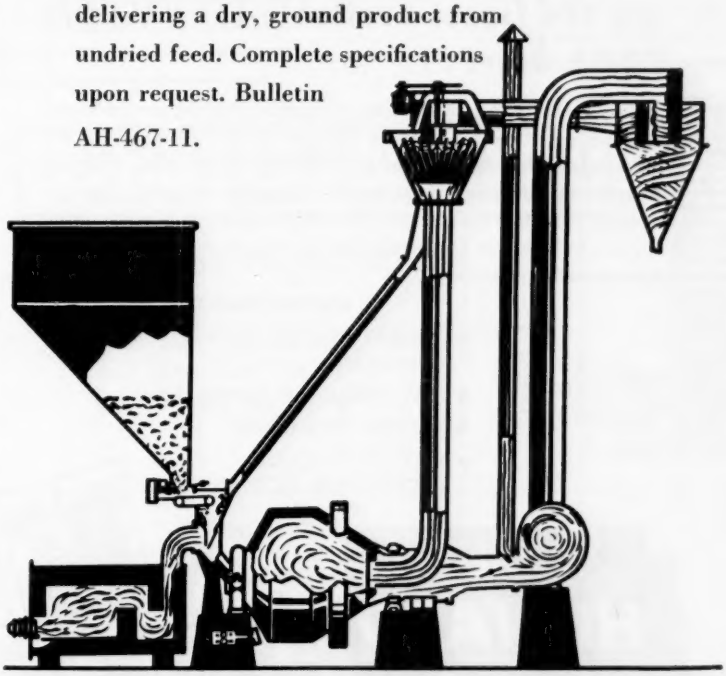

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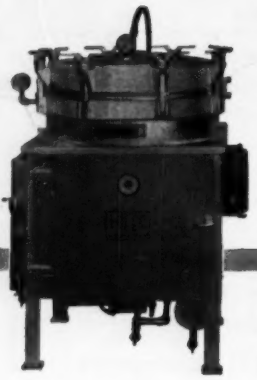

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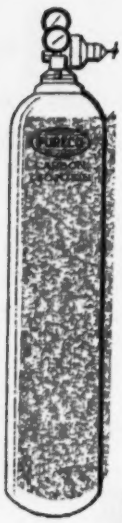
- CE Flow File (50¢).....**112**

* Don't forget to ask for your free copy of this issue's reprint feature (p. 171).

PURECO CO_2

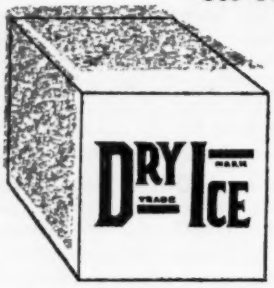
The answer to your problem?



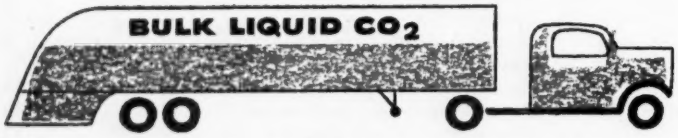
Investigate CO_2 as an Inert Gas for

- pharmaceuticals
- paints and dyes
- packaging
- purging and blanketing
- inert pressure transfer
- explosives
- powdering

Use CO_2 as a Refrigerant for



- pharmaceuticals
- grinding, plastics, resins, gums, etc.
- rubber tumbling
- vacuum traps
- low temperature testing
- lyophilizing



Specify CO_2 as an Ingredient in

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- foam rubber
- asbestos cement cure
- carbonation
- foam plastic
- water treatment
- manufacture of carbonates

Pureco CO_2 is quickly available—in solid "DRY ICE", liquid or gaseous form from over 100 sales and service depots. There are also a variety of Pureco CO_2 supply systems available—cylinders—cylinder banks, converters, receivers—each "tailored" to fit your particular requirements.

Pureco Technical Sales Service is qualified through its research in the field to assist you in adapting CO_2 to your particular process. Call Pureco today.

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READER SERVICE . . .

TECHNICAL

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Chemicals

Activated Carbons.....A complete line for every purpose; design & prefabricate complete purification, separation & recovery system to meet your needs. Bul. J-100.
R243 *Barnebey-Cheney

Adhesives.....20 p. "Armstrong Adhesives, Sealers, Coatings" devotes most space to tabulations of properties to various classes of adhesives.
230A Armstrong Cork Co.

Adhesives.....62 p. book, "Industrial Adhesives," covers selection, properties, production, design and testing for a wide range of products Price: $2.
230B Armstrong Cork Co.

Aerosol Cologne.....are estimated sixth in aerosol sales in 1958. Hair sprays, shaving lathers, room deodorants, insect sprays & coatings taking the first five places.
51-52b *U. S. Industrial Chemicals Co.

Alkyl Chlorides.....Butyl chloride, 2-ethylhexyl chloride, iso-decyl chloride are described in 12 p. bulletin F-6999A. Outlines applications, reactions.
230C Union Carbide Chemicals Co.

Aluminum Soap.....to gel solvents without use of heat. Bul. on product tells how to form stable gels from non-polar solvents & mixes of polar & non-polar solvents. No. 1455.
51-52j *U. S. Industrial Chemicals Co.

Ammonium Acetate.....are small, slightly moist, colorless to white crystals. They are very soluble in cold water & alcohol. Technical data is available.
91a *Allied Chem., Gen. Chem. Div.

Bleach.....26 p. booklet covers a sodium chlorite product for bleaching, oxidizing and stripping textiles. Sections deal separately with various applications.
230D Olin Mathieson Chemical

* From advertisement, this issue

LITERATURE

E. M. FLYNN

Butene-1 & Butene-2.....Complete information about Butene-1 and Butene-2 is now available. All technical details are in No. 1457.
51-52e *U. S. Industrial Chemicals Co.

Butenediol.....Bulletin A-109 describes the physical properties of 2-butene-1,4-diol and outline major types of reactions which it can undergo. Covers uses too.
231A General Aniline & Film

Calcium Acetate.....Its uses include the liming of rosins, catalyst in preparation of metal resinates & varied application in pharmaceuticals & foods. Tech. Data.
91c *Allied Chem., Gen. Chem. Div.

Calcium Carbonate.....Purecal is free from grit, has cubically shaped particles of accurate size. Samples and data are available on request.
28-29 *Wyandotte Chemicals Corp.

Chlorine & Caustic.....Liquid chlorine is available in 30-ton & 55-ton tank cars. Liquid caustic soda is available in 8,000 & 10,000-gal. insulated & lined tankcars & barges.
51-52a *U. S. Industrial Chemicals Co.

Cupric Acetate.....Reagent grade is used in the manufacture of synthetic fibers...technical grade in the manufacture of dyes, copper, mirrors & printed circuits. Data.
91b *Allied Chem., Gen. Chem. Div.

Filter Aid.....Solka-Floc is highly purified, finely divided cellulose. Adsorbs many metals such as iron, copper, other impurities. It makes a stable pre-coat.
221 *Brown Company

Filteraid.....Nerofil, carbon-based filteraid for difficult filtrations such as caustic or fluorated solutions. Available in 6 grades. An illustrated bulletin is offered.
222 *Great Lakes Carbon Corp.

Fluorescent Penetrant.....New spray-on Zyglo finds all cracks, pores, leaks in nonmagnetic materials. Illustrated bulletin includes low prices of Zyglo materials.
260 *Mangaflux Corp.

* From advertisement, this issue

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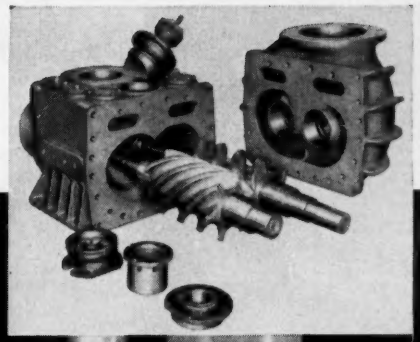
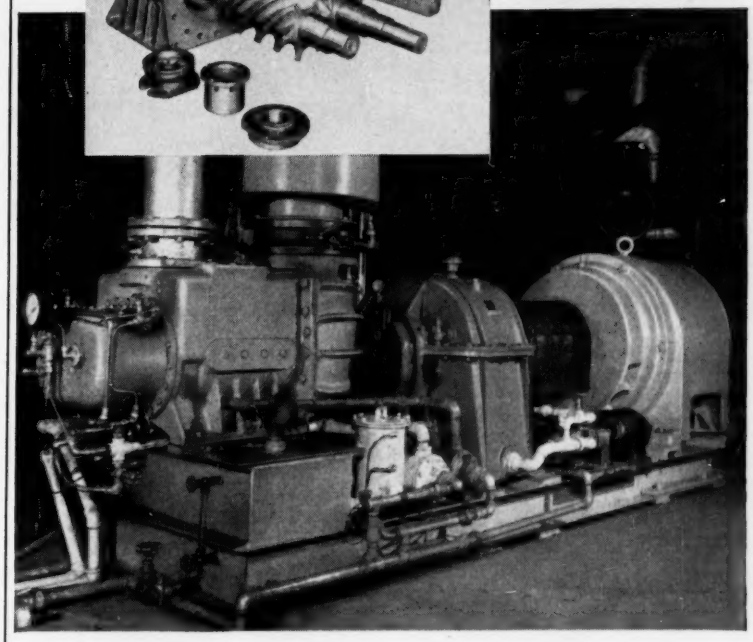


On display at International Petroleum Exposition, Tulsa, Okla., May 14-23



NEW *Fairbanks-Morse Positive Displacement Axial-Flow...*

Oil-Free Rotary Compressor

for pressure, vacuum or booster service!

Here is a mechanically-simple, precision-built, high-efficiency compressor that combines the best features of reciprocating and centrifugal designs!

The new Fairbanks-Morse Axial-Flow Rotary Compressor is a two-impeller helical-lobe type machine ...ideal for a wide variety of applications...smooth in performance, adaptable to any power source. Unit weights and space requirements are impressively low.

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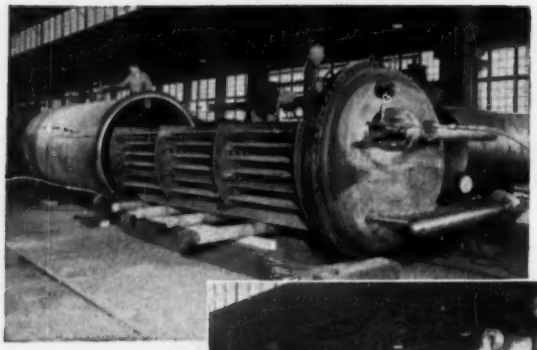
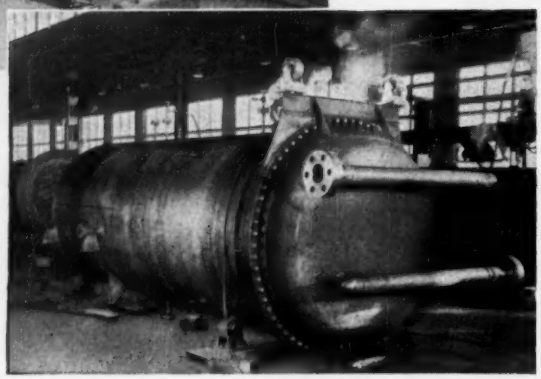


View showing how tube bundle slides out for ease of cleaning.



Vilter Synthesis Heat Recovery unit for Canadian chemical plant. Rollers being welded in place.

Vilter Vessel Salvages "Waste Heat" While Desuperheating Ammonia Gas!

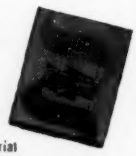
This Vilter synthesis heat recovery unit makes every BTU do double duty. Using waste heat from mixed synthesis and ammonia gas, this vessel vaporizes water at 45 psi to steam at the rate of 6640 pounds per hour. In the process the gas at 4800 psig is cooled from 495° F. to 328° F. The steam is then used in other plant operations.

This Vilter unit weighing 15 tons is 72" in diameter, 17' long, and has 1150 lineal feet of tubing. Croloy tubing and headers are used because at temperatures over 500° F. carbon steel would be de-carbonized by the nitrogen-hydrogen mixture. Shell and cover are of welded steel for tightness and strength. For easy cleaning, the "U" tube bundle slides out on rollers. This heat recovery unit is typical of the custom work Vilter is doing in the field of heat exchangers and pressure vessels to meet design and budget requirements.

Vilter can give you the most efficient heat exchanger equipment with working pressures as high as 10,000 psi. Vessels are built in conformance to the A.S.M.E. Code and when specified to T.E.M.A. standards.

Consult with Vilter for your special vessel needs.

Write for your free copy of this helpful bulletin to The Vilter Manufacturing Company, Dept. K-811, 2217 S. First Street, Milwaukee 7, Wisconsin.



Bulletin 827
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LITERATURE . . .

Furfural.....for product development or process improvement. Bulletin No. 203-A contains physical data on furfural. Now available on request. Send for your copy.
105 *Quaker Oats Co., Chem. Div.

Hydrogen Chloride.....4 p. leaflet contains process and operating information on production of anhydrous hydrogen chloride. Flow diagram, plant photos.
232A Chemetron Corp.

Lacquer Solvents ..... Methyl Ethyl Ketone is one of the most important solvents used in the formulation of acrylic lacquers. Provide durable finishes. Information.
101 *Enjay Company, Inc.

Laxatives.....12 p. bulletin describes the laxative-active fraction of cascara sagrada. New product is called Casanthranol. Chemistry, pharmacology, specifications.
232B S. B. Penick & Co.

Lubricants.....The Management Practices book is now available. This guide to organized lubrication discusses methods that help raise production, extend parts life.
93 *The Texas Company

Lubrication System.....The Miniature Accumite system offers all the advantages of built in measured lubrication, plus compact size. Facts on system available.
41 *Stewart-Warner, Alemite Div.

Menthionine Bibliography ..... A selected bibliography of published articles on the oral & topical applications of methionine is now available.
*U. S. Industrial Chemicals Co.
51-52d

Mercaptoethanol ..... 8 p. bulletin summarized typical chemical reactions of 2-mercaptoethanol and presents analytical methods for determining properties.
232C Union Carbide Chemical Co.

Methyl Borate.....is a widely-miscible, non-aqueous solvent, azeotroping agent, Lewis-acid catalyst & intermediate.
*U. S. Industrial Chemicals Co.
51-52n

Molybdenum Hexacarbonyl.....is now available commercially as a chem. intermediate catalyst & vapor phase deposition raw materials.
*U. S. Industrial Chemicals Co.
51-52h

Organic Chemicals.....78 p. list of company's general organic chemicals, alkaloids, steroids, spectrographically standardized substances, catalysts and others.
232D L. Light & Co. (England)

Plastic ..... Ryertex-Omicron PVC forms easily, cuts with a handsaw, welds readily with hot-air equipment, machines at high speeds on standard equipment. Bul. 80-3.
148 *Jos. T. Ryerson Steel

Plastics.....A new bulletin on Polyvinyl Chloride is now available on request. Full details on uses and applications are covered. Bulletin PF-1201.
BL239 *Luzerne Rubber Co.

Potassium Acetate.....may be used as a humectant in various industries, such as textiles & cigarette paper manufacturing. Also varied uses in pharmaceuticals. Tech. Data.
91d *Allied Chem., Gen Chem. Div.

* From advertisement, this issue

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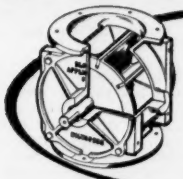

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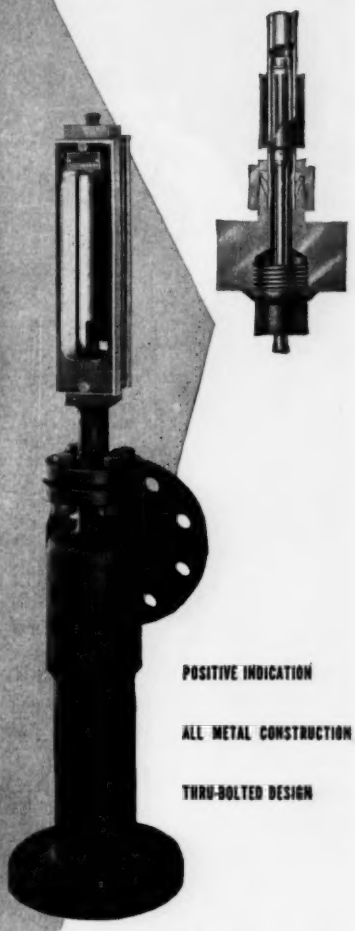

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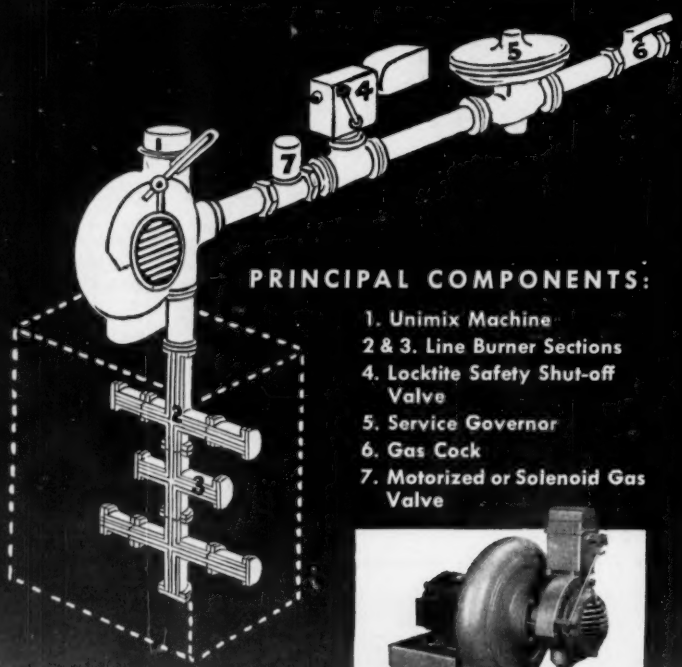

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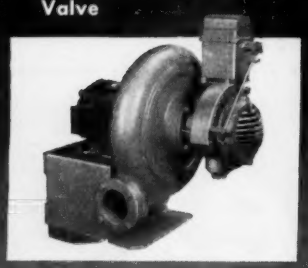

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123 *Metal Hydrides Inc.

Sodium Methylate.....powder or liquid catalyst for use in rearrangement of edible fats & oils, particularly lard & in mfg. of sulfa drugs, etc. 16-Pg. Booklet lists chemicals.
40 *The Harshaw Chemical Co.

Sodium & Potassium Borohydride..... A 34-page manual discusses properties, reactions & handling also 13 tables cover tech. data.
51-52e *U. S. Industrial Chemicals Co.

Thermoplastic Polymer.....Literature on the properties and uses of Penton and "The ABC's of Penton for Corrosion Resistance" are now available.
126 *Hercules Powder Co., Inc.

Construction Materials

Alloy.....The new booklet "Introduction to Ni-o-nel" describes composition, physical & chemical properties, plus suggested applications for Ni-o-nel nickel-chromium alloy.
64 *The International Nickel Co., Inc.

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246 *The Duraloy Company

Conduit..... Aluminum rigid conduit offers light weight & ease in handling. Easier to cut, bend & thread. Offers less voltage drop. New booklet is available.
103 *Aluminum Co. of America

Grating & Treads.....Bulletin No. 2527 contains detailed information on Electroforged steel grating & treads for your needs. Self-cleaning, designed for flexibility.
4 *Blaw-Knox Co.

Insulation.....Foamglas insulation is waterproof, vapor-proof, acid-proof, vermin-proof & dimensionally stable. Complete information in latest industrial brochure.
82 *Pittsburgh Corning Corp.

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L241 *The Ruberoid Company

Packing....."Lattice-Braid" teflon will withstand temperatures ranging from —90 F to +500 F. It is long-lasting & chemically-inert. Information in Catalog AD-131.
8-9a *The Garlock Packing Co.

Packings....Chempac Teflon packings in moulded & braided types for pumps & valves...in a wide range of flange & envelope-type gaskets ...in rings, cups, sheets & tapes.
19 *Johns-Manville.

Refractories.....Carbofrax silicon carbide refractory has high thermal conductivity & load-bearing strength at high temperatures. Booklet, "Super Refractories".
70 *Carborundum

* From advertisement, this issue

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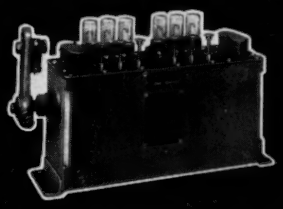

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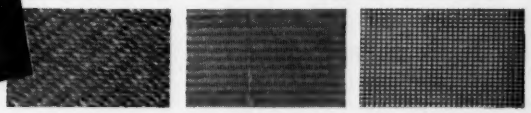

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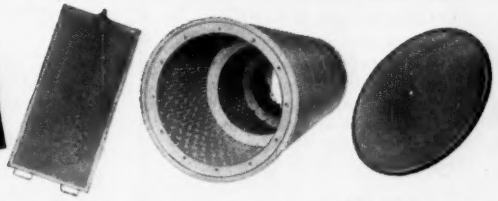

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MODEL MHG-30,000
MERCURY DIFFUSION PUMP

4-stage jet. No organic vapors to contaminate vacuum system. Pumps 45,000 liters per second from 5 x 10^{-4} to 5 x 10^{-6} mm Hg, with 53,000 peak at 7 x 10^{-4}. Maximum throughput: 37,000 micron liters/second at 7 x 10^{-4} mm Hg.

Write for data and specifications. Just ask for Bulletin 6-1.

Consolidated Electrodynamics

Rochester Division, Rochester 3, N.Y.

SALES AND SERVICE OFFICES IN PRINCIPAL CITIES

LITERATURE . . .

Titanium.....A comprehensive brochure tells how titanium is made, its advantages of strength and weight, and other physical properties. Corrosion rating chart.
236A Harvey Aluminum

Titanium.....for highly corrosive service. Information, "Cost Cutting Ideas in Titanium for Chemical Pumps, Valves & Accessories", is available on request.
138 *Mallory-Sharon Metals Corp.

Special Metals.....Brochure on wire, rod and shapes, now available in titanium, zirconium, tantalum, columbium and other special metals is offered by manufacturer.
236B Johnston & Funk

Stainless Steel.....New booklet summarizes factual information on stainless steel based on in-service corrosion tests & plant experience in the petrochemical industry.
59 *Armco Steel Corp.

Wire Cloth & Filter Cloth.....to your exact requirements in rolls or cut pieces or in fabricated components. Catalog outlines all types.
BL235
*Multi-Metal Wire Cloth Co., Inc.

Zinc Dust.....used as a reducing agent, precipitating agent, purifier, catalyst, polymerizing agent, in rust-resistant paints, bleaches, etc.
213
American Smelting & Refining Co.

Electrical & Mechanical

A. C. Motors.....Bulletin B-2103-4 gives concise selection data to users of a.c. motors from 1 through 200 hp. in size. Explanations of NEMA design classes.
236C Reliance Electric

Conduit Fittings.....Solid Aluminum Electrolets has resistance to corrosion. Gives extra strength at points of stress. Catalog of electrical fittings & fixtures offered.
74 *Killark Electric Mfg. Co.

Controls, Motor.....Starters & Circuit Breakers are explosion-proof, dust-tight & weather resistant. Built-in push button stations & selector switches available.
86 *Crouse-Hinds Co.

Drives.... All steel shaft mounted with hp range ½ to 50 np., output speed range 420 to 5 rpm. Torque ratings up to 41,000 lb-in. Information in Bulletin 7100.
47 *The Falk Corp.

Gaskets..... Teflon-jacketed gaskets come in four basic designs. Long-lasting for piping, flanges & fittings. Complete details in Catalog AD-154.
8-9b *The Garlock Packing Co.

Gears.. High-pseed reduction gears in twelve fames are available for most economical turbine speed selection in low-speed applications. Information available.
30-31c *Westinghouse Electric Corp.

Metal-Enclosed Bus..... Designed to aid in the selection of metal-enclosed bus for utility and industrial use, new bulletin gives ratings, construction details of firm's line.
236D I-T-E Circuit Breaker

* From advertisement, this issue

LITERATURE . . .

Motors.....Ribbed-frame enclosed motors include ratings up to 300 hp. Important facts about these motors are given in new Bulletin PB-6006-2 which is offered.
26-27 *Elliott Co.

Rectifier Systems..... Semiconductor power rectifier systems offer power conversion for the electrochemical industry. Complete information in Bulletins GEA-6684 & 6375A.
10-11 *General Electric Company

Seals, Mechanical.....A new file folder of mechanical seal designs shows some of the many types & applications possible for pumps, mixers, autoclaves, etc.
205 *Borg-Warner

Safety Heads.....are available in sizes ⅛" to 44" in exposed diameter of the rupture dics & in pressure ratings as low as 5 psi & as high as 10,000 psi.
38 *Black, Sivalls & Bryson, Inc.

Starters..... Details on combination starter in screw type enclosure for hazardous gas & hazardous dust locations, contained in Bulletin 713. Send for your copy.
81 *Allen-Bradley Co.

Starters.....Complete details on the 2200-4800 volt starters is now available. Throughout the entire sequence, motor windings are completely protected. Bul. 8210.
43 *The Electric Controller & Mfg. Co.

Transducers.....Details on the P/I (pressure-to-current) & its counterpart, the I/P (current-to-pressure) transducer are available. They're completely transistorized.
24-25 *Minneapolis-Honeywell

Tube Cleaner.....The new lightweight, air-driven tube cleaner for condenser & heat exchanger tubes is outlined in Bulletin Y-48. Easy to handle by one operator.
218 *Elliott Co.

Turbines, Multi-Stage.....Five frame sizes available with speeds to 16,000 rpm & horsepowers to 50,000 for paper machine drives, power plant generation up to 5000 kw.
30-31b *Westinghouse Electric Corp.

Turbines, Single-Stage ..... Seven frame sizes available with horsepowers from 5 to 4000, speeds from 1000 to 12,500 rmp. For pumps, fans, compressors, blowers, etc.
30-31a *Westinghouse Electric Corp.

Handling & Packaging

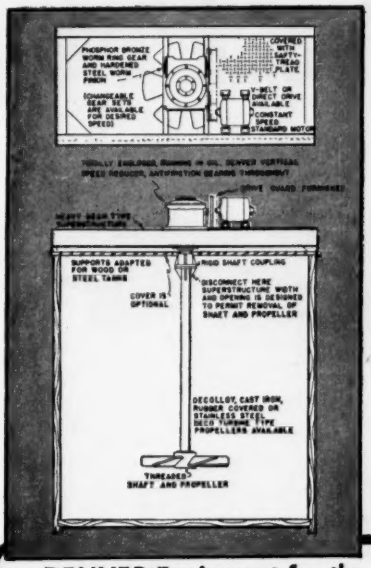
Bags & Sealer..... Information on MVT Multiwall Bags & MVT Sealing Machine are offered. Sealer applies same degree of protection for the ends as for the side walls.
97 *Hudson Pulp & Paper Corp.

Conveyors.....ChipVeyor systems for the collection and processing of metal chips and borrings and reclamation of cutting oils outlined in Bulletin C-56.
118b *National Conveyors Co., Inc.

Conveyors..... for press scrap and small parts and also Ash conveyor systems for handling ash & fly ash are covering in Bulletin P-57A which is now available.
118c *National Conveyors Co., Inc.

* From advertisement, this issue

CUT Agitation Costs up to 15%



DENVER AGITATORS AND MIXERS

DENVER designs and manufactures a complete line of agitators and mixing systems for slow speed, thorough stirring, high speed mixing, scrubbing, solvent extraction, solids suspension, leaching, or aeration of slurries. Complete Laboratory Testing Service.

DENVER Reducer Drive Agitator
Sizes to 32′ x 32′.

Write for Bulletin A2-B4.

DENVER Equipment for the Chemical Process Industries

DENVER SRL Pumps
Capacity to 3000 g.p.m.
Write for Bulletin No. P9-B10

DENVER Agitator-Type Disc Filters
Sizes to 9′ dia. x 12 Disc
Write for Bulletin No. F9-B5

DENVER Adjustable Stroke Diaphragm Pumps
1" to 10" Simplex and Duplex, Capacity to 1000 g.p.m.

DENVER Spiral Rake Thickeners
Sizes to 150′ diameter
Write for Bulletin No. T5-B6

DENVER-DILLON Screens
Sizes from 1′ x 3′ to 6′ x 14′
Write for Bulletin No. S3-B15

DENVER Steel Head Mills
Sizes to 10′ dia. x 20′ long
Write for Bulletin No. B2-B20

See our catalog on pages 647-654 in CEC Catalog

Specialists in Flotation Engineering

DECO ENGINEERS — DENVER EQUIPMENT COMPANY 24 HOUR SERVICE

DENVER EQUIPMENT COMPANY
BOX 5268, DENVER 17, COLO.

THIS PUMP SPECIALIZES IN

"IMPOSSIBLE"

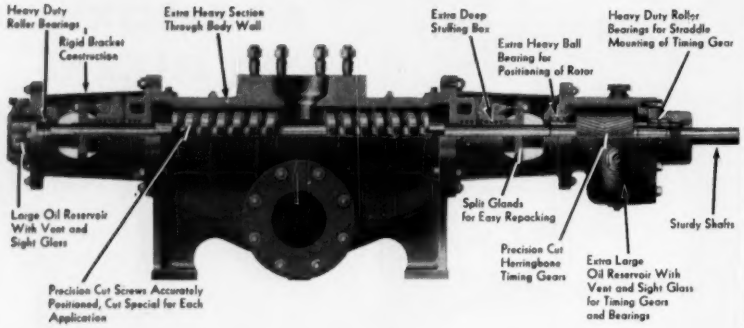
CHEMICAL PUMPING PROBLEMS

. . . examine these special features of the

WARREN

EXTERNAL GEAR AND BEARING

SCREW PUMP


Heavy Duty Roller Bearings
Rigid Bracket Construction
Extra Heavy Section Through Body Wall
Extra Deep Stuffing Box
Extra Heavy Ball Bearing for Positioning of Rotor
Heavy Duty Roller Bearings for Straddle Mounting of Timing Gear
Large Oil Reservoir With Vent and Sight Glass
Split Glands for Easy Repacking
Sturdy Shafts
Precision Cut Herringbone Timing Gears
Extra Large Oil Reservoir With Vent and Sight Glass for Timing Gears and Bearings
Precision Cut Screws Accurately Positioned, Cut Special for Each Application

. . . then see what it can do:

- Pumps highly viscous liquids or semi-liquids most effectively; discharge pressures nearly unlimited for high viscosity liquids; up to 700 psig for low viscosity liquids, with capacities to 3000 GPM and operating temperatures to 700°F.
- Pumps liquids from systems under high vacuum, with special modifications; has handled vacuums down to 10 microns, with no special seals or without submerging the pump. Mechanical seals are not required.
- Pumps many types of slurries, since it does not trap liquids as gear pumps commonly do.
- Pumps with a constantly high volumetric efficiency because of low internal slippage; is excellent for metering large capacities.
- Pumps quietly and smoothly and is ideal for extruding material where a flawless surface is necessary.
- This highly adaptable Warren External Gear and Bearing Screw Pump, available in an almost endless number of patterns, can solve special space or piping problems too. And it can be furnished with heating or cooling jackets, with hopper type body, and in any metal your problem requires.

Now, consult a Warren engineer for help with your "impossible" chemical pumping problem or write for detailed Bulletin 206

WARREN

CENTRIFUGAL | SCREW | RECIPROCATING | GEAR

WARREN PUMPS, INC.

WARREN, MASSACHUSETTS

C-10

LITERATURE . . .

Conveyors, Pneumatic.....Bulletin No. P58-G contains complete information on pneumatic conveyor systems for handling dry granular materials.
118a *National Conveyors Co., Inc.

Desuperheater..... Bulletin 1056 describes a carburetor-type desuperheater capable of supplying steam at a temperature within 5°F of plant requirements.
232A Copes-Vulcan Div.

Fork Lift Truck.....Circular covers complete operating and maintenance features of the new Model H electric fork lift truck. Offered in capacities to 2,500 lb.
238B Lewis-Shepard

Gas Containers.....6 p. folder, F-1254, describes a complete line of small containers for transport and storage of liquefied gases. Design and performance.
283C Linde Co.

Loading Arms.....deal with hard-to-handle corrosive chemicals, hydrocarbons & other fluids & gases in all kinds of weather. Descriptive literature.
58 *Chiksan Co.

Materials Handling.....The self-loading Dumpmaster handles 6 sizes of containers. One man operation... can't injure operator. Brochure gives all the facts.
54 *Dempster Brothers

Materials Handling Truck..... The Liftomatic is designed & constructed to eliminate use of hooks, & additional man-power in moving containers & chimes.
238D Marvel Industries, Inc.

Power Truck Attachment.....fits any truck & handles any drum. Illustrated bulletin offers complete specifications & other details of this Liftomatic attachment.
238E Marvel Industries, Inc.

Tanks.....of carbon & stainless steel for chemical storage. Also pressure vessels & processing equip. of aluminum & special alloys. Booklet "Tank Talks" is offered.
T259 *R. D. Cole Mfg. Co.

Heating & Cooling

Boilers, Packaged.....Complete information on packaged boilers (15 to 600 HP) and how they fit into your expansion or replacement plans are available on request.
203 *Cleaver-Brooks

Combustion Systems.....High-velocity air heating combustion systems are individually job engineered using standard components. Complete information on request.
234 *Eclipse Fuel Engineering Co.

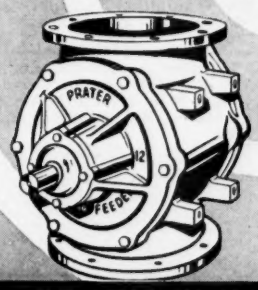
Dryers, Rotary.....Roto-Louvre dryers provide precise processing for heat-sensitive, friable & hydroscopic materials. Data on this & facts on dryer line in Book 2511.
12 *Linke-Belt Co.

Drying Oven.....for any heat problem in the heat processing industry. Complete information on drying ovens that adhere to close tolerances is available.
145 *Despatch Oven Co.

* From advertisement, this issue

2000 PROCESSING PROBLEMS SOLVED BY PRATER AIRLOCKS

SEND YOUR AIRLOCK FEEDER PROBLEM TO PRATER

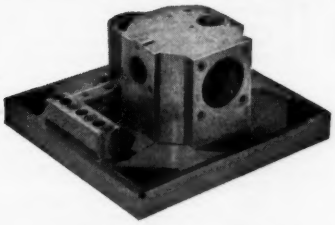


Write for Your Copy of "How to Select a Rotary Airlock Feeder" Bulletin P58

PRATER PULVERIZER COMPANY
1517 SOUTH 55TH COURT • CHICAGO 50, ILLINOIS

LRC LUZERNE

PLASTICS AND HARD RUBBER



PVC PART 14" square x 9" high 15 LBS.

◆ MOLDED PARTS

Specialists in heavy intricate CUSTOM PARTS, Heat-Resistant HARD RUBBER (264°F. — A.S.T.M.) PVC and other PLASTICS, Long and short runs.

◆ PIPE, FITTINGS, VALVES
◆ LINING TANKS, PIPE, CASTINGS
◆ ROLL COVERING
◆ FABRICATION, MACHINING
◆ SHEET, ROD, TUBE, SHAPES
◆ ENGINEERING DESIGN

WRITE Dept. CE FOR INFORMATION OR SEE US IN CHEMICAL ENGINEERING CATALOG

LUZERNE RUBBER COMPANY
MAIN OFFICE AND FACTORY — TRENTON, N. J.

ADAMS FACT FILE #3

INSTRUMENT AIR

Clean Dry Air Supply Will Reduce Production Down-Time . . . Instrument Maintenance . . .

Wet, dirty compressed air has no place in the process industries. In instrument air supply lines it can cause havoc. Whether it be motor air in a control circuit or supply air to the control panel, absolutely clean dry air is vital. Moisture elimination is the major consideration in providing suitable air for instrument and control systems.

Since most plant compressors in use today are oil lubricated, a finite amount of oil is present with the water vapor in the discharge. This carry-over condenses as an oil-water emulsion which often causes serious fouling of instrument components. To eliminate this oil-moisture condensate in the air lines, it is necessary to remove it before it reaches the distribution system. This is done by cooling the air before the receiver. It is advisable to cool well below the ambient conditions to provide the lowest possible humidity at the instrument panel or control units.

Two Stage System Design for Economy

The ideal method to achieve high quality air is a two-step operation.

1—An Adams Aftercooler . . . providing 2° F. cooling . . . and Cyclone Separator installed between the compressor and receiver to remove the bulk of moisture carry-over.

2 — A chemical dryer installed down stream to provide the polishing action necessary for the desired minimum humidity.

Thus, the bulk of water . . . 90% . . . is removed by the Aftercooler-Separator using plant water for cooling. A minimum moisture load is then left to be removed by more expensive methods. Under normal circumstances, all of the oil present in the compressor discharge will be removed in the Aftercooler-Separator. Fouling of the chemical unit is then virtually eliminated.

Poro-Stone Air Filter at Panel Provides Dirt-Free Control Air . . .

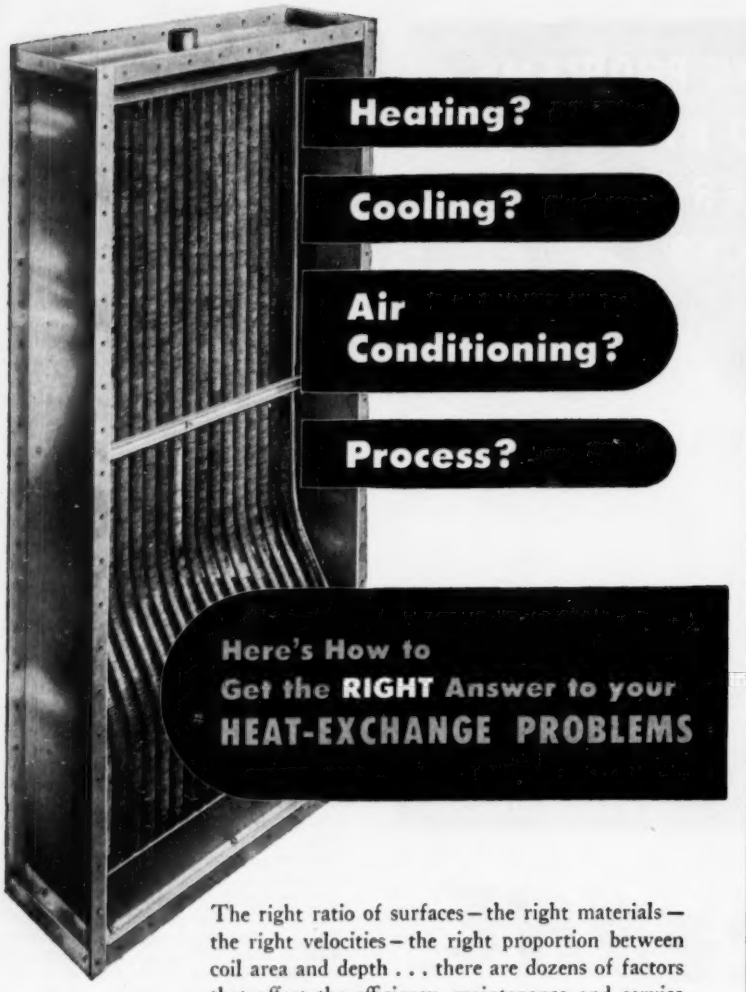
In spite of the efficiency of the Adams Aftercooler and Separator, there still will be some dust and dirt present in the instrument air system. That's why it is advisable to install an Adams Poro-Stone Air Filter in the line just before the control panel.

Separation by the Adams unit is in two stages — centrifugal and diffusion. Centrifugal force throws the foreign matter to the walls of the filter body where it is trapped in slots and drained. Remaining particulate matter is removed as the air passes through the pores of the Poro-Stone element.

This final protection for your instruments will minimize control system failures and process down-time. Instrument maintenance will be sharply reduced.

Literature Will Help Air System Design

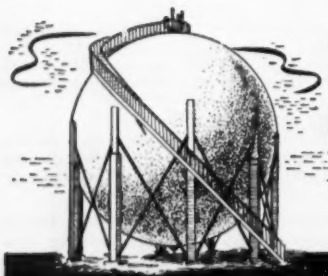
For further information on how the complete line of Adams air equipment can help you provide a foolproof instrument air supply, write today for your copy of Bulletin No. 712 on Aftercoolers and Separators and Bulletin No. 117 on Poro-Stone Air Filters to the R. P. Adams Company, Inc., 207 East Park Drive, Buffalo 17, New York.



The right ratio of surfaces—the right materials—the right velocities—the right proportion between coil area and depth . . . there are dozens of factors that affect the efficiency, maintenance and service life of heat-exchange coils.

For best performance in your own application, the practical approach is to take full advantage of the unequalled engineering, research and design skill — the unequalled manufacturing and testing facilities — which Aerofin offers you.

To get the *right* answer—ask the Aerofin man.



Throughout the Chemical Industry—

Aerofin units do the job Better, Faster, Cheaper

AEROFIN CORPORATION 101 Greenway Ave. Syracuse 3, N. Y.

Aerofin is sold only by manufacturers of fan-system apparatus. List on request.

LITERATURE . . .

Heat Exchanger.....offers the right ratio of surfaces, materials and velocities. Also the right proportion between coil area and depth. Information available.
240 *Aerofin Corp.

Heat Exchanger.....The Cross-Bore exchanger is available in capacities to 470 sq. ft. heat transfer surface. Quotation for your heat transfer requirements is available.
77 *Falls Industries, Inc.

Heat Exchanger Equipment.....with working pressures as high as 10,000 psi. Bulletin 827 outlines the industrial heat exchangers that are available.
232 *The Vilter Mfg. Co.

Heat Processing.....Bulletin No. 133 "Gradiation Heating for Petroleum and Chemical Processing" discusses the Gradiation Heaters for your heat process requirements.
128 *Selas Corp. of America

Heat Transfer.....coefficients in small sodium heat exchangers are discussed in a reprint now available. Complete details contained in No. 1452.
51-52g *U. S. Industrial Chemicals Co.

Liquid Heater.....operates at atmospheric pressure. Generates & delivers heat up to 650 F. Bulletins containing complete information on this new liquid heating system.
36 *Allis Chalmers, Hydraulic System

Preheater.....For details on air preheaters and information on potential fuel economy, a factual article is available. Slagging is reduced & cuts boiler downtime.
62 *The Air Preheater Corp.

Thermo Panels.....take the place of pipe coils. Can be quickly installed or removed for cleaning. Complete data, including prices is available. Send for your copy.
TL260 *Dean Products, Inc.

Instruments & Controls

Chromomax Analyzer ..... can be equipped with dual column switching or electronic integration. Analyzer solves process stream measuring problems. Application details.
50 *Leads & Northrup Company

Computers, Electronic.....LGP-30 is easy to operate, plugs into any regular wall outlet and is completely mobile. Detailed information & specifications offered.
130 *Royal McBee Corp.

Controller.....The complete story on the Dynalog Electronic Controller with full-scale spans as narrow as 5 F. is contained in Bulletin 20-10. Send for your copy.
53 *The Foxboro Co.

Controls.....New recording pneumatic temperature control, model RVA is available in any of 10 ranges from 30 to 1100 F. Recording, indicating & non-indicating models. Details.
48 *The Partlow Corp.

Controls.....Printweigh "400" for complete printed weight records. It prints full figures, even when unit weights are used. Complete details in Bulletin 2017.
216 *Toledo Scale Corp.

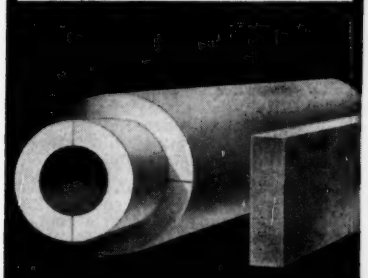
* From advertisement, this issue

RUBEROID

Calsilite

ONE-LAYER INSULATION!

Now a modern molded calcium silicate insulation for use on today's high temperature pipes and vessels. Insulates with only *one* layer, providing a constant co-efficient of conductivity. Available in various thicknesses of pipe coverings and blocks, Calsilite is insoluble in water, can withstand normal acids and alkalis . . .



FOR SOAKING HEAT UP TO 1250° F!

- Light weight
- Resists abuse
- Easy to cut and mitre
- One layer does the complete job
- Absorbs moisture without disintegration

For complete details, write:

The RUBEROID Co.
INDUSTRIAL PRODUCTS DIVISION
500 Fifth Ave., N. Y. 36, N. Y.
PIONEERS IN CALCIUM SILICATE INSULATION

LITERATURE . . .

Gas Meters, Rotary.....are available in a wide range of sizes, capacities from 2,000 to 1,000,000 cfh at pressures to 600 psig. Bulletin M-258 contains details.
63 *Roots-Connersville Blower

Gauges, Pressure.....Duragauges are available in pressure ranges from 15 psi (or vacuum) minimus to 100,000 psi. Choice of three case materials. Facts.
60 *Manning, Maxwell & Moore, Inc.

Index of Literature.....New 24-page bulletin lists available literature on company's instrumentation line. Specifications, Technical Bulletins, Systems Bulletins, etc.
241A Minneapolis-Honeywell

Indicators.....Sight Flow are easily & inexpensively installed to show movement of liquid in pipe lines. Available in Transparent & Reflex types. Data Unit offered.
L249 *Jerguson Gage & Valve Co.

Magnetic Flowmeter.....lets you set and flow at full scale...from 1 to 30 fps. Can Measure reverse flows without auxiliary equipment. Catalog 10D1416.
17-18 *Fischer & Porter Co.

Manometers.....Two manometers of new design are illustrated and described in a new catalog. Literature also describes 12 other models of the Series 30 line.
241B Trimount Instrument Co.

Measurement & Control..... Bulletin RF-583-5 outlines the quantitative measurement & control system to fit your requirements. Includes details on continuous level indicator.
147 *Robertshaw-Fulton Controls Co.

Rotameter..... Bulletin 130 outlines the complete line of AR-Met rotameters that are available for every service. Both electrical & pneumatic meters.
R233 *Brooks Rotameter Co.

Testing Device.....The Plastic Deflecthe complete line of AR-Met rota-60 cycles, singe phase a.c. Dimension 26 x 16½" x 23" high. Information in Bul. 2307C.
209 *American Instrument Co., Inc.

Viscometer, Rotating Cylinder.....designed for measurement of liquids at low shear stresses. Particularly useful for accurate studies of high-molecular-weight polymers.
51-521 *U. S. Industrial Chemicals Co.

Pipe, Fittings, Valves

Basic Check Unit.....made of stainless steel, they'll handle almost any liquid, gas or air...over a broad range of pressure-temperature ratings. Bulletin CE 39.
214 Durabla Mfg. Co.

Connectors, Flexible.....MNH flexible connectors dampen vibration, permit offset movement, absorb expansion, etc. Fact-filled Allflex Engineering Data Sheet offered.
BL233 *Allied Metal Hose Co.

Expansion compensation..... offer working pressures to 175 p.s.i. for ¾" & 1" sizes; to 125 p.s.i. for larger sizes up to 3". Informative & helpful Catalog #163R.
183 Flexonics Corp.

* From advertisement, this issue

first

ZIRCONIUM PUMPS

ECO "GEARCHEM" NOW MASS-PRODUCED FROM FORMER RARE ALLOY

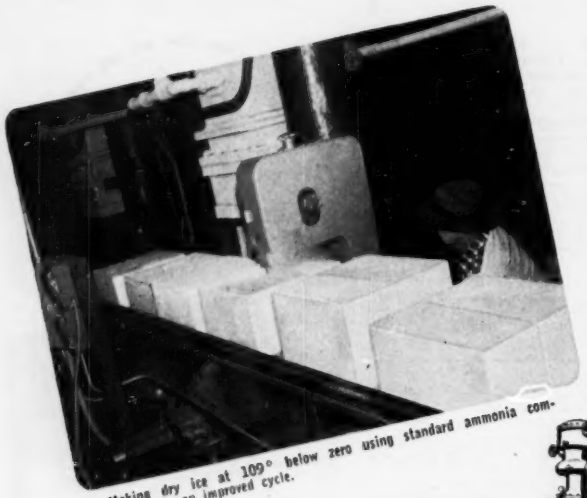
COMMERCIALLY PRICED FOR

STANDARD PROCESS SERVICE REQUIRING RESISTANCE TO HOT CORROSIVES SUCH AS

HCl at 300°F

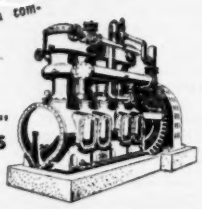
No contamination of acid with metallic salts through progressive dissolution, as with other metals. Wear-compensated, chemically-inert Teflon Gears. Grease-sealed stuffing box—Leak-proof against pressure or vacuum in open or closed loop systems. Write for details.

ECO ENGINEERING COMPANY
12 New York Ave., Newark, N. J.



Making dry ice at 109° below zero using standard ammonia compressors in an improved cycle.

"HEAVY DUTY" COMPRESSORS



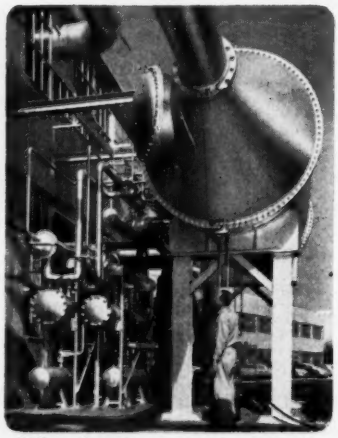
FRICK

ENGINEERS

WILL DESIGN . . . BUILD *and* INSTALL FRICK SYSTEMS . . .

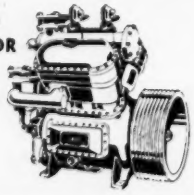
to solve your most difficult cooling problems.

If you need any type of industrial or commercial cooling—for quick freezing, cold storage, ice making, humidity control, low temperatures, condensing, air conditioning, or any process work—contact the nearest Frick Branch or Distributor for recommendations and estimates.



Cooling air under pressure for supersonic speed tests.

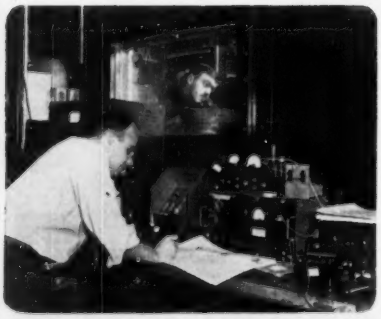
"ECLIPSE" COMPRESSOR



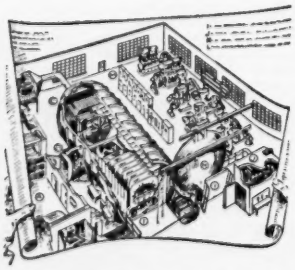
DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA., U. S. A.



Test laboratory work for temperatures down to 140° below zero.



All-weather Laboratory built for U. S. Army. Uses 3-Stage compressors, mantains Arctic, tropic and stratospheric conditions.

LITERATURE . . .

Expansion Joints.....Self equalizing expansion joints absorb movement in any direction, axially, laterally, angularly, or any combination of these. Catalog 56.
71 *Zallea Brothers

Fittings.....Usco Weld features fast, easy assembly, automatic alignment of pipe & fittings & strong joint interference. Details available on Usco Weld & plastic pipe & fittings.
197 *U. S. Rubber

Fittings, Welding.....any type of special fittings made form plate to the most rigid specification. Closer tolerances & quality control. Bul. 5801 for details.
55 *Midwest Piping Co.

Hose & Pipe.....Bulletins outline the applications in the chemical industry for acid hose and flexible rubber pipe. They discuss all types for your requirements.
131 *Raybestos-Manhattan, Inc.

Pipe....."Jal-Jacket" pipe is available in 20-ft. mill lengths in three sizes 2⅜", 3½", & 4½" O.D. Handles corrosive liquids. Details available. Send for your copy.
22-23 *Jones & Laughlin Steel Corp.

Pipe, Polyvinyl....for a variety of uses in the chemical industry. Resistant to many chemicals, including acids, alkalies, salt solutions & alcohol. Bul. 24.
78 *U. S. Steel, National Tube Div.

Pipe, PVC.....is available in sizes ¼" through 6" in schedules 40, 80, and 120. A new 32-page illustrated catalog on this pipe is available.
69 *A. M. Byers Co.

Piping Systems, Plastic.....equipment for corrosion-service. Also a complete line of plastic valves. A new handbook for design of plastic piping systems is offered. No. 159.
111 *Chemtrol

Spray Nozzle....."Cant-Clog" spray nozzle is now available as a replacement on all makes of spray equipment . . . as caps only or complete nozzles. Information.
R245 *Carrier Corporation

Spray Nozzles.....Complete information on spray nozzles contained in Catalog 24. Offered in a wide range of types & capacities for every application.
TL243 *Spraying Systems Co.

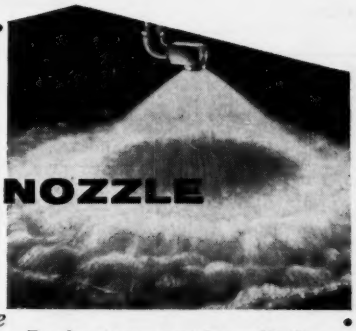
Tube.....Trufin type S/T integral finned condenser tube is covered in a new book "Design & Cost Comparisons" now available.
49 *Wolverine Tube Div., Calumet & Hecla

Tubing.....Data compiled from extensive tests under actual operating conditions are available as a help in solving tubing problems in power plant equipment.
136 The Carpenter Steel Co.

Valve.....The new "O-Seal" valve features two tefion "O" rings in the plug which give constant vapor-tight shut-off. A new brochure on these valves is offered.
57 *Wedgeplug Valve Co.

Valves.....Positive shut-off is assured by pressurized lubricant sealing between the valve plug & the body. Complete line of lubricated plug valves. Booklet V-203.
45 *Rockwell Mfg. Co.

* From advertisement, this issue



got a
SPRAY NOZZLE
problem?

perhaps one of our **DATA SHEETS** *can suggest a solution*

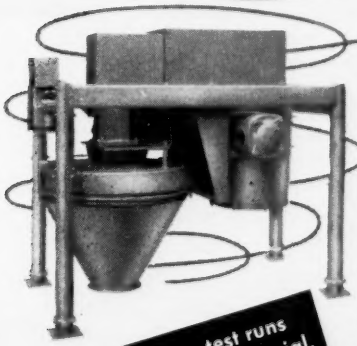
For almost every spraying application, there's a Spraying Systems Data Sheet that gives useful information on suggested installations and types of nozzles to use. If you have a problem, write and let us know the application involved . . . and we'll send the Data Sheet that applies.

SPRAYING SYSTEMS CO.
3275 RANDOLPH STREET • BELLWOOD, ILLINOIS

And . . . for complete spray nozzle information, write for Catalog 24.

MIX BETTER BY

IMPACT



Finer and more intimate dispersion of solids can be achieved using an Entoleter® centrifugal impact mill.

- Low cost — low power requirements
- Minimum (controlled) temperature rise

RECENT APPLICATION

For the final dispersion of detergent, bleach, perfume and highly abrasive silica flour in a popular powdered household detergent, this 27" model with abrasion resistant impactors does the job.

Free test runs on your material.

Send for literature on Impact Milling, Particle Size Reduction and the new line of Vibrating Screens.

ENTOLETER
DIVISION OF SAFETY INDUSTRIES, INC.
P. O. Box 904, New Haven, Conn.

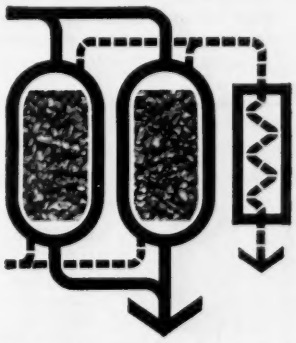
how to trap a ghost

Before solvent vapors fly out the window, many smart users literally wring them out of the air into liquid form, good as new, at costs as low as 2c a gallon—with activated charcoal recovery systems. Bonus: you may also raise worker efficiency with the right atmosphere, reduce heating costs.

how to keep your spirits

Distillers who store alcohol in barrels watch the level go down as the age goes up. Now—distillers may use activated charcoal to turn costly vapors into pure liquid form, fresh as the dew—with very attractive savings. Activated charcoal recovers many expensive vapors for as little as 2c per gallon.

activated carbon



We supply a complete line of activated carbons for every purpose; design and prefabricate complete purification, separation, and recovery systems to meet your particular needs. Write for Bulletin J-100 and recommendations on your specific application. Barnebey-Cheney, Columbus 19, Ohio.

Barnebey Cheney

Sonic puts

ULTRASONICS

to work

..in Polishes for a shinier shine and a longer protection a major polish manufacturer now homogenizes their polish ultrasonically. The better their blend the better their polish, they found... and the smaller the particles the better the blend. The Dispersonic gave them the smaller particles at a fraction of the first cost and power of conventional equipment... and paid for itself in one year by lowered maintenance costs.

..in Insecticides the problems of the insecticide chemist just begin when he finds a good insecticide. Then he must feed a tiny droplet to each bug... or spread a thin layer on the bug or plant. The micron-sized drops from Sonic homogenizers will get more bugs "plastered" with more droplets from the same amount of insecticide than ever before.

Sonic Homogenizers develop and use all the energy right in the liquids with only 1/6 to 1/10 the power, and at a fraction of the first cost, of conventional equipment... maintenance-negligible.

The Dispersonic
...abrasive emulsions

Other Models
MINISONIC
...for small batches
SANISONIC
...meets sanitary requirements
AUTOSONIC
...continuous supply
RAPISONIC
...production homogenizer

Sonic homogenizers can give you a superior emulsion, too. Send for technical bulletin

Sonic

SONIC ENGINEERING CORPORATION
146 Selleck Street, Stamford, Conn.

LITERATURE . . .

Valves.....Nine new flanged and forged steel Gate, Globe & Check valves are available. Literature on sizes, pressures and types of the complete line is offered.
181 *Henry Vogt Machine Co.

Valves, Ball.....Details on the snap-lock type (now available with Viton-A-trim) and the top entry type is now available. Contains complete specifications, etc.
65 *Rockwood Sprinkler Co.

Valves, Butterfly.....Bullet'n describes extended line of 125-lb. butterfly valves. Information includes cut-away drawings, photos, dimensional data for sizes 4 to 48.
242A B-I-F- Industries, Inc.

Valves, Diaphragm.....Complete information on straightway or standard weir types, handwheel, lever, or power operated is now available on request.
72 *Grinnell Company, Inc.

Valves, Gate.....Wedge disc bronze gate valves feature rising stem & non-rising stem patterns. Complete technical data including size listing in Circular AD-2340.
115 *Crane Co.

Valves, Refrigeration.....New catalog shows prices and information on the manufacturers line of refrigeration valves, fittings and supplies. Refrigerant tables.
244B Frick Co.

Valves, Steel.....Globe, Angle, "Flo-control", Lift Check and Hi-Pressure Drop designs are available. The 600# valve in sizes ¼" thru 2". Full details.
34 *Manning, Maxwell & Moore, Inc.

Process Equipment

Centrifugal.....Illustrated details on Tolhurst centrifugals time & space-saving advantages is now available. Also data on the Batch-O-Matic centrifugal.
207 *American Machine & Metals, Inc.

Blenders.....Specialized information & complete data in Bulletin No. 16, Chemical Process Equipment and Bulletin No. 15A-1, Twin-Shell Laboratory Blenders.
88-89 *Patterson-Kelley Co.

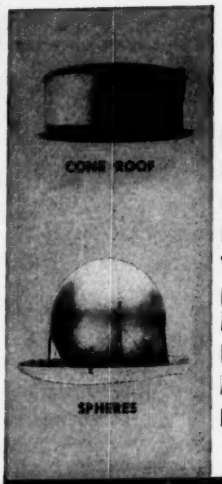
Classifier, Air.....“Gyrator” system combined with a grinding mill is an integrated grinding, classifying & product conveying system. Specifications in Bul. AH-467-11.
225 *Harding Co.

Compacting System.....is a package of integrated equipment; the new compacting mill, a roller mill & either a gyratory or vibrating screen. Details in Bulletin 07B8836.
189 *Allis-Chalmers

Crusher, Saw Tooth.....Its hard faced 16" diameter breaker saws are designed specifically for the reduction of tough or brittle materials. Specification Sheet No. 204.
1a *Sprout-Waldron

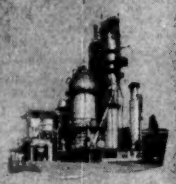
Crushers & Grinders.....Design provides easy access for cleanouts & returns complete sample. Bul. No. 067 gives full description of all laboratory machines.
R249 *Sturtevant Mill Co.

* From advertisement, this issue



STEEL PLATE
STAINLESS STEEL
STAINLESS CLAD PLATES
T-1 STEEL AND OTHER STEEL ALLOYS
NICKEL-CLAD
ALUMINUM
ETC.

HAMMOND TANKS



FIELD ERECTED TANKS AND VESSELS FOR LIQUIDS, GASSES VAPORS AND STORAGE OF DRY MATERIALS

FIRE PROTECTION AND WATER SUPPLY

HAMMOND IRON WORKS
WARREN, BRISTOL and PITTSBURGH, PA.
PROVO, UTAH • CASPER, WYO.
BIRMINGHAM, ALA.

Sales offices throughout the U.S.A.

"See? You can't beat *Mallinckrodt Stearates* as mold-release agents!"

Seriously speaking...

You can't beat **Mallinckrodt Stearates** for adaptability in industrial processing...

...as mold-release agents for plastics and rubber.

...as flatting and suspending agents in paint and varnish.

...as modifying agents for surfaces of machine-coated papers.

...as gelling agents in oils and greases.

Stearates are among the many Mallinckrodt process chemicals—of dependable purity, uniformity and physical form—used in more than 200 industries.

Good reason for you to call **Mallinckrodt** next time you have a question, a problem, or a need for the most dependable chemicals made.

Linking Chemistry to Industry!

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MALLINCKRODT CHEMICAL WORKS
ST. LOUIS · NEW YORK · MONTREAL

LITERATURE . . .

Desuperheater.....The SK Venturi type is designed to reduce the temperature of super-heated steam to the lower temperatures for use in process operations. Bul. 6D.
73 *Schutte & Koerting Co.

Dissolvers.....for ultimate dispersion, dissolving, emulsifying & deagglomerating in processing solid-liquid, liquid-liquid & gas-liquid materials. Information in catalog.
61 *Morehouse-Cowles

Disc Separator.....for accurate separating & sizing by length. Separators vary in number of discs & size of the disc pockets. Complete information available.
202b *Simon-Carter Co.

Dryer.....Hydryer continuously removes moisture from gas or air stream at full line pressures. Bulletin gives application details, selection tables, etc.
TL251 *J. F. Pritchard & Co.

Dryers.....In rotary vacuum dryers the blade clearance is adjustable down to ⅛ inch. Full information on cone vacuum dryers, drum dryers & flakers is available.
56 *F. J. Stokes Corp.

Drying Equipment.....guaranteed for paint pigments, tobacco, leather, fabrics, foods & drugs. Copies of the new proctorpak bulletin are now available.
132 *Proctor & Schwartz, Inc.

Feeders, Airlock.....available in standard duty, heavy duty & blow-thru types. Bulletin P-58 "How to Select a Rotary Airlock Feeder is offered.
TL239 *Prater Pulverizer Co.

Filter.....The Horizontal Tilting Pan Vacuum Filter provides up to 560 sq. ft. of filter area. Complete information, layouts & estimates plus pilot-scale test data offered.
2 *Bird Machine Co.

Filter.....Model HR offers horizontal plate cake stability plus dry cake discharge . . . all automatic. Complete details on this new filter are available.
110 *Sparkler Mfg. Co.

Filter Presses....New catalog helps you figure the filter area & capacity required for your process & the size of filter press needed. Available now.
210a T. Shriver & Co., Inc.

Filter, Rotary Pressure.....Data is available on these filters & filters for your individual requirements. Details on size, construction materials, etc.
83 *American Machine & Metals, Inc.

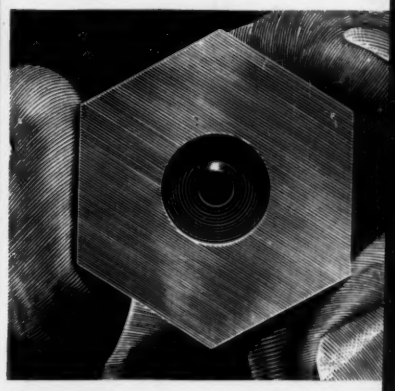
Filters.....Bulletin EF/2 features Wet & Dry Cake Discharge Design charts & complete illustrations of the Filtration Cycle of vertical pressure filters.
245A ..The Duriron Company, Inc.

Filters.....constructed of monel, combine a porous metal facing on a frameless metal edge element. Two brochures outline what they can do for your filtration requirements.
185.. ..*Purolator Products, Inc.

Filters.....Catalog, including detailed information of plate-shifters, closing devices & other labor-saving accessories for your filtration problems is offered.
215 *D. R. Sperry & Co.

* From advertisement, this issue

Here's something you've never seen before!



NEW Carrier "CANT-CLOG"* SPRAY NOZZLE

Cuts maintenance costs on air washers, cooling towers and spray equipment

Proved in more than three years of service as standard equipment on Carrier air washers, this revolutionary new centrifugal type spray nozzle is now available as a replacement on all makes of spray equipment—as caps only or complete nozzles.

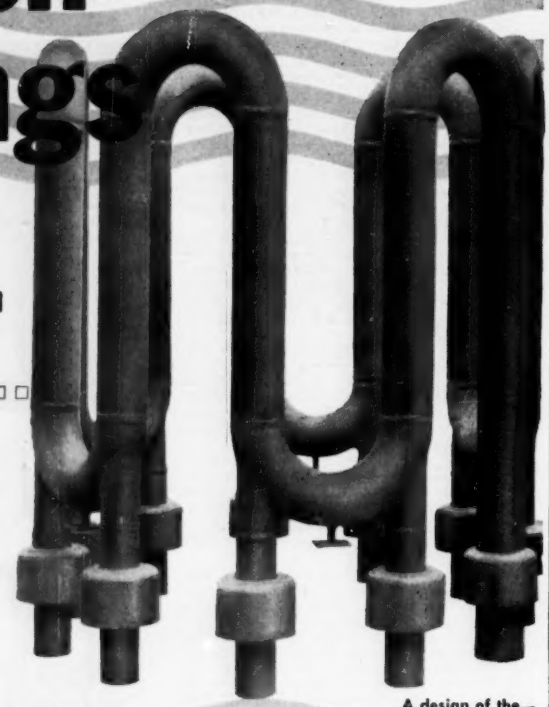
It's self-cleaning. It installs in seconds. It's low in cost. And since the orifice is formed in a flexible Buna-N rubber dome, erosion normally caused by restricting particles is eliminated. You get longer nozzle life, less down-time and better equipment performance.

For ratings and complete information on this money-saving new development write Carrier Corporation, Syracuse, N.Y.

* Patent Pending

Carrier

when things are HOT... call on Duraloy



A design of the A. F. Holden Co., Detroit, Mich.

Castings that Keep their Load-Carrying Strength at High Temperatures

This "immersion type radiant heater" is typical of the high reliability castings turned out by DURALOY. Centrifugally cast tubes with *UNIFORM* wall thickness...for longest service life. Static cast collars and shell molded bends...typical of DURALOY versatility.

For your high alloy casting requirements check with DURALOY... our long experience, ultra-modern foundry and up-to-the-minute test equipment will be helpful in solving your problems. For more information ask for Bulletin No. 3150 G.

The DURALOY Company

OFFICE AND PLANT: Scottdale, Pa.

EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

LITERATURE . . .

Gas Scrubbers.....A new brochure giving complete data on Chemico venturi gas scrubbers is available. Their simple construction permits wide application.
33 *Chemical Construction Corp.

Grate Magnets.....for positive, low-cost magnetic protection in trouble spots that are difficult to guard. Wing & drawer types available. Details in Bul. 1213A.
BL247 *Dings Magnetic Separator Co.

Grinding Mills.....for wet or dry grinding. Available in 29 different diameter sizes, from 12" to 12'6" inside diameter. Capacities up to 6650 tons per 24 hr.
211 *The Mine & Smelter Supply Co.

Homogenizers.....develop & use all the energy right in the liquids with only 1/6 to 1/10 the power. Technical bulletin gives all the facts.
L244 *Sonic Engineering Corp.

Hydrator.....The new C-41 Super-D-Hydrator easily handles polyolefins & other difficult purifications. Capacity on polyolefins is from 1 to 3 ton per hour.
134 *The Sharples Corp.

Mill, Impact.....Literature on Impact Milling, Particle Size Reduction and the new line of Vibrating Screens is now available.
BL243 *Safety Industries, Entoleter Div.

Mills, Impact.....New bulletin tells most efficient method of achieving particle size reduction by centrifugal force. Mills available in all sizes to meet requirements.
246A Safety Industries, Entroleter Div.

Mixer.....The Mix-Muller features large hoods, spring loaded mullers, removable crib section and bottom discharge. A new bulletin on mulling is now available.
35 *National Engineering Co.

Mixer, Batch.....produces finished product in one operation. A new catalog describes the Troy line of angular mixers, colloid mills, roller mills & unit blenders.
BL251 *Troy Engine & Machine Co.

Mixers, Centrifugal.....Available in all sizes to meet individual requirements. Bulletin outlines new principle of high speed mixing producing intimate dispersion.
246B Safety Industries, Entoleter Div.

Oil Reclaimer.....purifies vacuum pump oil by continuous recirculation, either on a full-flow or by-pass basis or intermittently on a batch basis. Bul. R-160.
226 *The Hilliard Corp.

Precision Grader.....for accurate separating & sizing of plastic resins & other free-flowing granular materials by width or thickness. Various models & sizes. Information.
202a *Simon-Carter Co.

Pressure Vessel.....Design Handbook covers a complete range of pressure vessels up to 131¾" I.D. & 844 pounds psi working pressure. Available now.
212 *American Car & Foundry

Processor.....Vacu-Film processor simplifies complex & difficult processing problems, particularly on time-at-temperature sensitive materials. Details in Bul. PE-98.
246 Rodney Hunt Machine Co.

* From advertisement, this issue

When the design calls for
an indicating gauge, specify
the best–
MARSH
New catalog covers gauges for every need
MARSH INSTRUMENT CO.
Sales Affiliate of Jas. P. Marsh Corporation
Dept. 24, Skokie, Ill.
Marsh Instrument & Valve Co. (Canada) Ltd.
8407 103rd Street, Edmonton, Alberta
Export Dept.,
3501 Howard Street, Skokie, Ill.

DINGS GRATE MAGNETS

for positive, low-cost magnetic protection in trouble spots that are difficult to guard . . .

Under, over or in steep-sloped hoppers

Mounted in floor openings

Drawer-type for vertical ducts

At discharge end of conveyors or spouts

Dings Permanent Alnico Grate Magnets assure positive protection from tramp iron damage in trouble spots which never before could be effectively guarded. They are the only units of this type designed with unshielded magnets which contact the material directly to provide powerful attraction for fine particles of fuzz iron as well as larger pieces of tramp iron. Recommended for powders and granular materials. Both wing and drawer types available in sizes and shapes for every need.

Write for details in Bulletin 1213A.

DINGS MAGNETIC SEPARATOR CO
4730 W. Electric Ave.
Milwaukee 46, Wis.
G-158⅓

Dings

EXTREME PURITY

DELHI-TAYLOR TRIPLE-TESTED AROMATICS

Delhi nitration grade Benzene and Toluene and Delhi Xylenes have set a new standard in purity and uniformity. They are sulfur and thiophene-free with remarkably low paraffin content.

Delhi-Taylor keeps a careful watch over product purity through its unique "Triple-Testing" procedure.

The first test is made on-stream where rigid process control standards are maintained; the second test is made in storage to make certain that the product maintains its high quality during storage; the final test sample is taken from the barge or tank car before it is released to the customer.

This strict quality control formula is your assurance that Delhi-Taylor aromatics will readily meet the most stringent specifications.

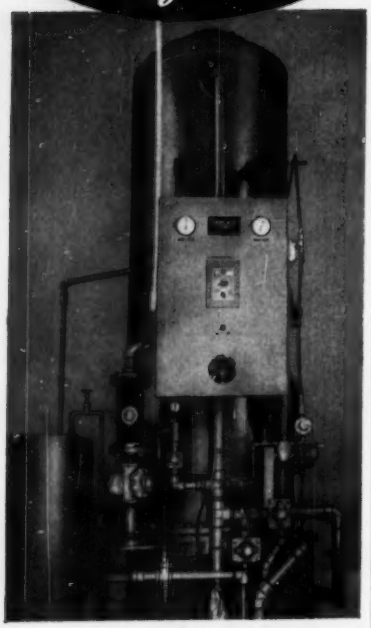
DELHI TAYLOR

CHEMICAL DIVISION
DELHI-TAYLOR OIL CORP.
415 Madison Ave. • New York 17, N.Y.

Need Ultra-Pure Process, Make-Up or Rinse Water?

Check the pioneer maker* of "Packaged" Demineralizers

Penfield



- **Purity in excess of 15-meg ohms** — where you need it, in the quantities you need.
- **Fully Automatic Operation** — set one switch to accomplish entire regeneration cycle.
- **Shipped Completely "Packaged"** — each unit is ready to operate when you receive it.

Penfield Demineralizers are available in mono-column, dual-column and multi-column types — in flow rates from 10 to 10,000 G.P.H. Fifty standard models to choose from. If complete system engineering is needed, that's a Penfield specialty too.

Write today for full catalog information. If possible, give flow rate and purity requirements.

PENFIELD
MANUFACTURING CO., INC.
19 High School Ave., Meriden, Conn.

**Penfield pioneered "packaged" demineralizers for American industry — and remains today the only manufacturer exclusively making demineralizing equipment.*

LITERATURE . . .

Processing Equipment.....Modern techniques in metallurgy, welding, or testing for producing processing equipment. The handy index to the ASME Code is available.
13 *Downington Iron Works, Inc.

Processing Equipment.....The Electrofining precipitator pilot plant pre-tests processing possibilities. Processing is precise, automatic & continuous. Facts offered.
204 *Petrolite Corp.

Rotating Contactor.....for all types of liquid-liquid contacting operations. Capacity from 200 cc/min. to 3,000,000 gph. Temp. from —100 F to +400 F. Pressure to 600 psig.
6-7 *Podbielniak, Inc.

Screens, Vibrating.....Important new design, compact, high capacities, low power requirements for long life under rugged conditions. Bulletin offered.
248A Safety Industries, Entoleter Div.

Strainers.....Automatic self-cleaning strainers for efficient removal & disposal of suspended particles from raw or process water & other liquids. Bulletin 500.1.
B259 *S. P. Kinney Engineers, Inc.

Stream Splitters.....Complete facts on the line of precision stream splitters is now available. Bulletin 137-B contains all the details on operation, etc.
1b *Sprout-Waldron

Sublimer.....Turbo-Entrainer sublimer offers purification by continuous sublimation. No fumes, dust, odors, or losses. Detailed information is available.
107 *Wyssmont Company, Inc.

Turba-Film Processor.....has wide application in atmospheric and low vacuum ranges. Literature is now available with details for your requirements.
84a *Rodney Hunt Machine Co.

Vacu-Film Processor....extends the range of thin-film processing into high vacuum . . . to one-half micron. Literature contains details for your requirements.
84b *Rodney Hunt Machine Co.

Water Purification Equipment..... Catalog "G" describes water stills in capacities of from ½ to 1000 g.ph. Catalog 127 covers Mix-Bed, Two & Four-Bed Demineralizers.
135 *Barnstead Still & Sterilizer Co.

Wet Dust Collectors.....The UW-4 Washers are ideal for high loading condition. They are self-cleaning & fire & explosion proof. Information in Bul. W-7456.
16 *The Ducon Co., Inc.

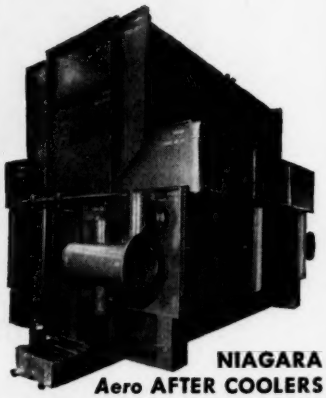
Pumps, Blowers, Compressors

Air Equipment.....Information on Aftercoolers and Separators contained in Bul. #712. Bul. #117 on Poro-Stone Air Filters is also available.
R239 *R. P. Adams Co., Inc.

Blowers.....Capacities of 22 production models range from 50 to 4,000 CFM, pressures to 14 PSIG single, 70 PSIG multi stage. Full information is available.
208 M-D Blowers, Inc.

* From advertisement, this issue

ECONOMICAL COOLING OF GASES and COMPRESSED AIR



NIAGARA
***Aero* AFTER COOLERS**

● Cooling gases or cooling and removing moisture from compressed air, the Niagara *Aero* After Cooler offers the most economical and trustworthy method. Cooling by evaporation in a closed system, it brings the gas or compressed air to a point close to the ambient temperature, effectively preventing further condensation of moisture in the air lines. It is a self-contained system, independent of any large cooling water supply, solving the problems of water supply and disposal.

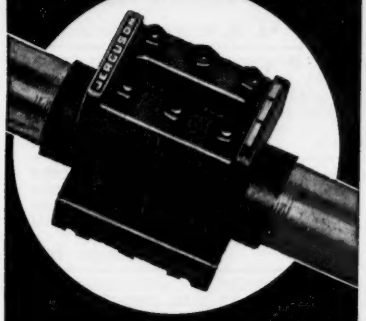
Cooling-water savings and power-cost savings in operation return your equipment costs in less than two years. New sectional design reduces the first cost, saves you much money in freight and installation labor and in the expense of upkeep.

Niagara *Aero* After Cooler systems have proven most successful in large plant power and process installations and in air and gas liquefaction applications.

Write for Descriptive Bulletin 130

NIAGARA BLOWER COMPANY
Dept. CE-3, 405 Lexington Ave.
NEW YORK 17, N. Y.
District Engineers in Principal Cities of U. S. and Canada

NEW . . .
Jerguson Sight Flow Indicators



easily and inexpensively installed to show movement of liquid in pipe lines

Here is a new line of Sight Flow Indicators . . . easily and inexpensively installed in any new or existing pipe line ½" to 2" N.P.T.

The special design of these new indicators results in a turbulence in the flow of liquid, making it easily visible. Several types of indicating vanes, installed within the chamber, may also be furnished, according to variable conditions of rate of flow and viscosity of liquid. For indication of minute flows, small Sight Flow Indicators with a rotating vertical rising ball are available.

Jerguson Sight Flow Indicators are soundly designed, carefully made, and are backed up by a company with over 40 years experience in the field. Available in Transparent and Reflex types, in a wide variety of materials and linings, and with Wedge Type Illuminators, Haveg Chambers, Non-Frosting Glasses, or other special construction.

If you have a problem of viewing the flow of liquid in a pipe line, it will pay you to investigate the new Jerguson Sight Flow Indicators today. Send us your requirements or write for Data Unit.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Adams Street, Burlington, Mass.
Offices in Major Cities
Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

LITERATURE . . .

Compressor, Rotary.....The new Axial Flow rotary compressor is a two-impeller helical-lobe type machine . . . ideal for a wide variety of applications. Bul. ACO 100.1.
231 *Fairbanks-Morse

Compressors.....Full details on how the advanced axial & centrifugal compressor designs can save you money on your compressed air requirements in Bul. 277-11.
20-21 *Joy Manufacturing Co.

Compressors.....from single stage to six stages, from 125 to 25,000 psi pressure, for such gases as; acetylene, air, argon, ethane, helium, nitrogen, etc. Catalog 44.
220 *Norwalk Co., Inc.

Compressor, Oil-free.....Bulletin A-44 provides pertinent data on 14 sizes of a heavy-duty industrial compressor. Capacities from 95.6 to 939 cfm. Section drawings.
249A Joy Mfg. Co.

Fans, Corrosion Resistant.....Bulletin F/20 offers complete construction & size selection details. Charts & specifications of all types for handling all corrosive fumes.
249B The Duriron Company, Inc.

Pump, Centrifugal.....features corrosion resistant construction for chemical solutions. Available with open, enclosed or explosion proof motors. Bulletin 120.
117a *Eastern Industries, Inc.

Pump, Diaphragm.....A double-acting piston pump without packings . . . No leakage . . . easy to clean. Capable of discharge pressures to 100 psi. Bulletin 137A.
210b T. Shriver & Co., Inc.

Pump, Screw.....Bulletin 206 discusses the special features of the external gear & bearing screw pump and how it can help with your impossible chemical pumping problems.
238 *Warren Pumps, Inc.

Pump, Single Stage.....Type SB single stage, double suction, split case centrifugal pumps are designed for ½ to 15hp motors . . . 1800 to 3600 rpm speeds. Folder offered.
224 *The Weinman Pump Mfg. Co.

Pump, Solids.....Bulletin gives complete operating data in both graph and tabular form for the Torque-Flow nonclog solids pump. Dimensioned drawings.
249C Wemco

Pump, Suction.....designed specifically to handle volatile sludges & slurries. Details on non-clogging slurry & sludge pumps contained in Bulletin 206-4.
217 *Lawrence Pumps Inc.

Pump, Vacuum.....Bulletin 6-1 outlines the model MCF-40,000 oil diffusion pump and model MHG-30,000 mercury diffusion pump. Covers all data specifications.
236 *Consolidated Electrodynamics

Pumps.....Oil-lubricated models handle a wide range of ratings up to 3500 gpm capacity, with heads to 500 ft. They handle hot or corrosive liquids.
191 *Allis-Chalmers

Pumps.....The H Durcopumps are built with capacities from ½ to 3500 gpm, & with heads to 345'. Available in 12 standard corrosion resisting alloys.
195 *The Duriron Co.

* From advertisement, this issue

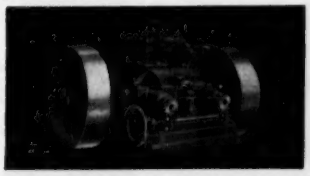
Take Guesswork Out of Lab Crushing & Grinding

Sturtevant Design Provides Easy Access for Cleanouts — Returns Complete Sample

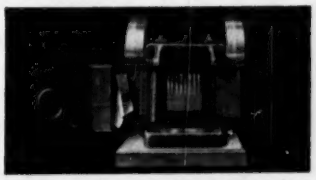
In seconds, because of "Open-Door" accessibility, all Sturtevant crushing or grinding parts are exposed for thorough cleanouts. 100% sample return is easy to secure.

Sturtevant laboratory machines are ruggedly constructed — design, based on production models, gives top lab or pilot performance.

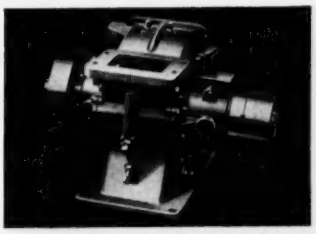
Send for Bulletin No.067, which gives full description of all Sturtevant laboratory machines.



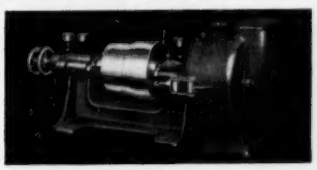
Lab Crushing Rolls: Special lab design. Two models: 8 x 5 in. and 12 x 12 in. rolls. Capacities to 10 tph. Both models adjust down to 20 mesh. Tires of high carbon forgings. Automatic feeder, adjustable controls.



Lab Jaw Crusher: Crushes hardest rocks at ½ to ⅛ in. settings. Roll jaw action — no clogging. Feed opening 2 x 6 in. Capacity to 1900 lbs. per hr. at ½ in. setting. Instant adjustment. Manganese jaws, reversible shield.



Lab Swing-Sledge Mill: 5 x 6 in. opening takes soft, medium, tough or fibrous feed. Capacity to 1 tph. Fines regulate from 1 in. to 20 mesh. Choice of gratings, hammers (or knives).



Sample Grinder: Disc type grinders for dry, friable soft or medium materials. Three sizes — 6 in., 10 in., and 14 in. take feed as coarse as ¼ in. Produces 100 mesh fines at capacities to 200 lbs. per hr. on largest model. Regulate 10 to 100 mesh. In-operation adjustment.

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LITERATURE . . .

Pumps.....Cradle mounted types CLFC, CLC, CMC, & CHC are outlined in Bulletin 247. All features, metal specifications and dimensions are covered in detail.
250A Warren Steam Pump Co., Inc.

Pumps.....for all corrosive applications. Pumping parts are available in a variety of metal alloys, as well as plastics. Complete information offered.
261 *A. R. Wilfley & Sons, Inc.

Pumps, Displacement.....with flow rates from ½ gpm to 5-½ gpm, pressures from 30 to 200 psi. High pressure outputs with small, low power units. Bul. 220.
117c *Eastern Industries, Inc.

Pumps, Glassed Centrifugal.....Choose from 4 different sizes & get capacities up to 700 GPM, heads up to 140 ft. Bul. 725.2 plus booklet, "It's What's Inside That Counts".
99 *Goulds Pumps, Inc.

Pumps, Hydraulic.....with flow rates from 0.1 to 9.8 gpm, pressures from 0 to 1500 psi. High efficiencies in handling hydraulic oil, fuel & lubricants. Bul. 810.
117b *Eastern Industries, Inc.

Services, Processes, Misc.

Automatic, Lab-Bench Zone Refiner.....just developed will give high-purity organic reagents from run-of-bottle chemicals. Said to purify any materials with 50-300° CMP.
51-52k *U. S. Industrial Chemicals Co.

Biochemistry.....The 1958 edition of "Annual Review of Biochemistry" can now be purchased. It is a 775-page volume containing 22 sections by different authors.
51-52f *U. S. Industrial Chemicals Co.

Data Books.....Free catalog of pocket size technical data books selling for $1.25 ea. Books cover every field of engineering, e.g., chemical tables, physics, math.
250B Lefax Publishers

Fabrication.....Booklet, "Facilities and Products" outlines the types of pressure vessels & other heavy process equipment fabricated by this company.
68 *Newport News Shipbuilding

Fluidics.....covers such varied phases of fluid handling & control as: corrosioneering, waste treatment, polymerization, fluid analysis, evaporation, drying, etc.
46 *Pfaudler Permutit Inc.

Nuclear Reactor.....It is the first private industrial installation. Fields of interest of the participants include alcohol, chemicals, special metals, plastics, etc.
51-52c *U. S. Industrial Chemicals Co.

Standard Fuel Elements.....in 4 types, for use in low-power research reactors. Complete information on these elements is contained in No. 1458.
51-52m *U. S. Industrial Chemicals Co.

Welding.....Methods and specific information are outlined in the illustrated Weldment Bulletin 7001. The welding of pressure vessels is one of the many jobs detailed.
76 *Baldwin-Lima-Hamilton

* From advertisement, this issue

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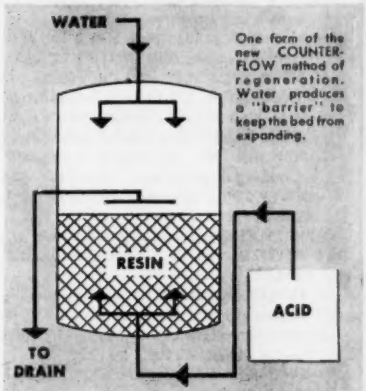
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RESIN
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- De-ionizer in a power plant. Conductivity of effluent improved from 10 micromhos to 4 micromhos after conversion to COUNTERFLOW. Cation leakage, expected at 4 ppm with downflow regeneration, actually is only 1 ppm.
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- Distillery in Middle West. TDS in raw water, 575 ppm. Expected cation leakage with conventional equipment, 6 ppm; with COUNTERFLOW, is actually only 1.5 ppm.
- Western power plant, converted to COUNTERFLOW. Savings in acid reduction, $16,000.00 per year. TDS in raw water, 342 ppm. Predicted cation leakage from curves for conventional design equipment, 4 ppm; with COUNTERFLOW, actually only 1.6 ppm.

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1—PFAUDLER 200 gal., glass lined, jacketed, agitated Reactor.
1—NOOTER 750 gal. Reactor, 300 PSI jacket.
1—72" x 30' STAINLESS STEEL Column, 20 bubble cap trays, type 347.
1—RAYMOND #3036 High Side 3 Roll Mill.
8—JEFFREY Hammer Mills, 8"x15"; 12"x20"; 18"x24"; 24"x36" motor driven.
1—HARDINGE 8'x30" Conical Ball Mill.
3—TOLHURST 40" S.S. Centrifugals, Susp.
2—FLETCHER 40" Steel Centrifugals, Susp.
1—FLETCHER 30" STAINLESS Suspended, Centrifugal, perforated basket, vaporite.
2—OLIVER 5'3"x3' Precoat Filters 316 STAINLESS STEEL, Vaportite.
2—SHARPLES C20 SS Super-D-Hydrators
2—SHARPLES PN 14 Super-D-Canters, S.S. 316.
4—KOMAREK-GREAVES 27"x23" Briquetting Presses, Feeders & 75 HP motors.
5—VULCAN, ALLIS CHALMERS Rotary Kilns motor driven, 8'x100'; 8'x125'.
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4—Link Belt ROTO LOUVRE DRYERS, steel 502-16, 705-24; stainless 604-24.
1—BONNET 7'x60'x½" Rotary Dryer lifters.
3—NICKEL Heat Exchangers (169) ⅞"x10' NICKEL Tubes, 338 sq. ft.
15—CUPRO-NICKEL Heat Exchangers: 177; 346; 1035; 2330; 5200 sq. ft.
25—Steel Heat Exchangers: 189; 880; 1042; 2060; 3900; 4420 sq. ft.
1—INDUSTRIAL Type SS-2 STAINLESS Pressure Leaf Filter, 195 sq. ft.
1—NIAGARA STAINLESS Filter, 54 sq. ft.
3—SWEETLAND #10, #12 Filters, STAINLESS and steel leaves.
18—SHRIVER SPERRY 18" to 36" wood; steel; aluminum. Filter Presses.
5—STURTEVANT 14' Whizzer Separators.
1—RAYMOND 30" double Whizzer Separator.
10—TYLER-HUMMER Screens, 4'x6'; 4'x8'; with Thermionic Controls.
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1—18" dia x 24" long, stainless steel evaporator.
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1—13" dia. x 12' long heat exchanger, with nickel tubes. 100 PSIG working press.
1—30' Ore Cooler 9" dia. jacketed screw type, stainless steel (3—10' sections, stacked).

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1—Double Drum Dryer (Blaw Knox) 32" x 100" cast iron drums, spray feeders, stainless enclosure. (Blaw Knox)
1—Oliver Drum type filter, 3' dia. x 6' face. Stainless steel with fabric liners.
1—Oliver Disc type filter, 4 discs, 4 feet dia. Stainless steel w/fabric liners.
2—Vacuum filters, Dollinger, type CVH-6.

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1—5000# Fairbanks tank scale. Dial type, with Bristol recorder, stainless tank.
3—2500# Fairbanks tank scales (same as above).

Refrigeration Unit

1—10 HP Worthington refrigeration unit with motor, compressor, and tank.

Reactors, Tanks, Bins, etc.

3—Inconel reactor tanks 58" D x 78" deep.
1—Rubber lined leach tank 58" Dia x 5' deep.
1—Stainless Steel 18" dia. x 36" deep.
2—Rubber lined 58" dia. x 54" deep (cone bottoms)
1—Plain Steel 60" dia. x 60" deep (flanged top)
3—Portable hopper bins 4½' dia. x 5' deep.
1—Stainless Steel Jacketed vessel (15# wkg. press) 66" dia. x 84" long.
4—Bins for dry storage 16' dia. x 14' high.
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2—Stainless vat. 30" wide x 4' deep x 32" long.
1—Stainless vat. 3 x 4 x 4.
1—Rubber lined. 42" wide x 80" deep x 24' long.

Crushers—Mills

1—Symons 4' standard coarse Cone Crusher.
1—Allis Chalmers 8-K gyratory for primary work.
1—Traylor double roll type AA (54" dia. x 24").
1—Traylor double roll type A (30" dia. x 16").
2—Superior double roll type (36 x 16).
1—Kennedy Van Saun Ball Mill 3' x 6', Air Swept.
1—Abbé Co. Pebble Mill, 42" x 6', Buhrstone lining.

Air Compressors

1—Ingersoll Rand 175 HP 17" x 14" Duplex, 35 psi.
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1—AT&M 26″ suspended Centrifuge, perforated basket, 316 S.S.
2—Oliver 8′ x 8′ Precoat rubber covered Rotary Vacuum Filters.
1—Oliver 3′ x 4′ lead Rotary Vacuum Filter
4—Sperry 36″ rubber covered Plate & Frame Filters, 30 chambers.
2—Sperry 42″ Aluminum Recessed Filters, 30 chambers.
4—42″ aluminum Recessed Filters, 36 chambers.
4—Shriver 36″ wood Plate & Frame Filters, 44 chambers.
5—Struthers-Wells 8′ dia. x 24′ high rubber lined Vacuum Crystallizers.

PULVERIZERS AND MILLS

4—Mikro Pulverizers, 3TH, 2TH, motor driven.
2—Abbe 5′ x 16′ brick lined Mills.
3—30″dia. Stainless Steel Micronizers complete with Hoppers, Conveyors, etc.

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1—Traylor 11′ x 155′ Rotary Kiln, ¼″ shell welded, 2 tires.
1—Vulcan 8′ x 125′ Rotary Kiln, ¼″ shell riveted, 2 tires.
1—Vulcan 8′ x 50′ Rotary Kiln, ¼″ shell welded, 2 tires.
2—Rennenberg 6′ x 60″ Rotary Kilns, ¼″ shell riveted.
1—Traylor 5′ x 50′ Rotary Dryer, 716″ sheH welded, 2 tires.
1—Proctor & Schwartz 8′ wide x 60′ long Conveyor Dryer, Stainless Steel Belt.

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4—3400 gal. 8′ x 8′ with Nettco Turbo Agitators, 15 HP motors.
1—4000 gal. 10′ x 7′6″ with Nettco Turbo Agitator, 10 HP motor.
1—4500 gal. 9′ x 9′ with Nettco Turbo Agitator, 3 HP motor.
1—5000 gal. 9′ x 10′ with Nettco Turbo Agitator, 15 HP motor.
5—8500 gal. Vertical Storage, 8′6″ x 16′ x 8′ cone.
1—10,500 gal. Horizontal Storage, 10′ x 18′.
1—13,000 gal. Horizontal Storage 8′ x 35′.

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4—2000 gal. 7′ x 7′ with Nettco Turbo Agitators, 10 HP motors.
1—3000 gal. 8′ x 8′ with Patterson Turbo Agitator, 10 HP motor.
1—5200 gal. 10′ x 9′ with Patterson Turbo Agitator, 10 HP motor.
15—Storage Tanks: 3800; 6000; 9000; 10,000; 15,000; 47,000 gal.

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3—Worthington, I.R. Compressors; 1000, 500 & 365 cfm, 30 psi.
4—Worthington, I.R. Vacuum Pumps, 1000 and 500 cfm.
11—Steel Buildings 20′ to 80′ trusses.
2—Shepard Niles 20 ton Overhead Cranes.
7—Dorr Thickeners; 16′ dia. with Tanks.
1—Bemis 50# Bag Packer with Sewing Machine, Conveyor and Flattener.
125—LaBour, Durco, Worthite, Duriron and Stainless Steel Centrifugal Pumps 2″ to 6″ with motors.

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1—750 gal. nickel clad Mixing Tank, 125# internal, with nickel coils.
1—10,000 gal. Horizontal Steel Pressure Tank, 200# psi.
1—Blaw-Knox 1400 gal. steel, jacketed, agitated Vacuum Kettle.
4—Buflovak 750 gal. steel, jacketed, double motion paddle, agitated Kettles.
1—4000 gal. 347 S.S. jacketed Reactor, 150# internal.
2—Pfaudler 1500 gal. glass lined, jacketed, agitated Reactors, 90# jacket.
1—Blaw-Knox 500 gal. 347 S.S. clad, jacketed, agitated Reactor.
2—Patterson 1000 gal., steel, jacketed, agitated Reactors, 20 HP.
3—Louisville 8' x 50' stainless steel lined Rotary Dryers.
3—American 42" x 120" Double Drum Dryers, 10 HP motors.
1—Buflovak 48" x 40" nickel, single drum Flaker.
2—Buflovak 250 & 20 sq. ft., 304 S.S. forced circulation Evaporators.
1—Buflovak 550 sq. ft. Monel Single Effect Evaporator.
5—Stainless Heat Exchangers, 1220, 1080, 786, 500, 370 sq. ft.
1—Bird 24" CH stainless steel Continuous Centrifuge.
1—Bird 48" Fume tight 316 S.S. suspended Centrifuge.
2—Sharples PN14 & PY14 Super-D-Canters, 316 S.S.
1—Sharples H2 Nozzlejector, 15 HP, 304 S.S.
1—Bird 40" suspended Centrifugal; 347 S.S. imperforate basket, 1800 rpm.
2—Sharples C27 Super-D-Hydrators, 316 S.S. and monel.
1—Bird 18" x 28", 316 S.S. continuous Centrifuge.
2—Sparkler 33-S-28 Pressure Filters, 150 sq. ft., 304 S.S.
1—Niagara 36 H-110 horizontal 304 S.S. Filter, 110 sq. ft.
1—Baker Perkins #16 TRM, 150 gal., jacketed sigma blades, Vacuum Mixer.
3—Stokes R single punch Tablet Machines, Unused.
1—Vulcan Briquetting Press, 30" dia. x 12½" face, 304 S.S. rolls, 50 HP.
1—Dowtherm 360,000 BTU Vaporizer.

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4—Komarek-Greaves vertical Fluxers (paddle mixers), 150 HP.
4—K-G Horiz. Fluxers 41" dia., 50 HP.
4—K-G Pug Mills, 30" dia. x 14'4".
8—Tyler Screens, 4' x 8', 4' x 6'.
2—42" wide travelling-screen cooling conveyors, total of 950'.
4—36" x 24", 24" x 18" Jeffrey hammermills, 50 HP, 25 HP.
6—Robinson Sawtooth Crushers.
2—Pa. Crusher #C-3-30 hammermills.
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MILLS—HAMMER—25 Hp Wms.—30 HP Mikro 3W—50, 100 HP Wms.—125 HP Jeffrey 36" x 42"—400 HP Penna. 24 x 72" (5XT 14)
MILLS—PEBBLE—36" x 42"—36" x 48"—5' x 6'—6' x 5' porc. lined—4½' x 16" Hard. Conical, Buhrstone
AUTOCLAVES—40 Gal. S/S—100 Gal.—150 Gal. Jacketed/agitated.
SCREENS—3 x 5 (single/double)—3' x 10' double—4 x 10 single Tyler Hummer—20" x 81"—40" x 84" Rotex (single/double)—42" x 10' Cedar Rapids (double)—5' x 12' double Robins
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Mills Mikro Bantam, 2TH and 24".
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Colloid: 3, 5, 20, 25 hp.
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Day 40 gallon Pony Mixer with AC motor
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SS Spray Dryer 4'x10½' complete unit
Patterson ¾ gal. SS Jkt'd Lab Mixer, 2 hp

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American Sterilizer 30"x48"x54".
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Pfaudler 6' diameter Stainless Steel Evaporating Dishes; Jktd. Agtd.
Pfaudler 6' Glass Lined Evaporators and (1) 47" diameter with Agit.
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Rotating Jacketed Aluminum Vacuum Fermenter; 3'x8'.
1500 gal. Steel Jacketed and Agitated Heavy Duty Pressure Vessel.
A. O. Smith Stainless Lined 11,000 gal. Pressure Tanks; 10x18'7"; 135 PSI.
ASME Aluminum Reactor 5050 gal. Manhole Type; 8'x12'; dished heads.
Lancaster Stainless Lined Rotary Reactor, 50"x17'4"; 350 PSI; Jacketed.

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A.T.&M. 26" Stainless Suspended Type Centrifugal.
A.T&M. Rubber Cov. 30" Susp. Centrifugal; AnnDisch.
Tolhurst 36" S/S Suspended; with Plow and Bottom Dump.
A.T.&M. 60" S/S Suspended center slung; vapor tight.
Sharples S/S Super-D-Canter; 10 HP.
Sharples H2 Nozzlejector; 1000 GPH.
Sharples C20 Super-D-Hydrator in 316 Stainless; 20 HP.
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43—Baker-Perkins size #17, 200 gal. jacketed sigma blade mixers, many with individual motors and drives, many with mechanical tilting devices, some with counter weights.

1—Baker-Perkins #15-USE, 100 gal. dispersion blades, T304 SS, jacketed, vacuum cover, 75 HP.

1—Baker-Perkins #15, 100 gal. sigma blade, jacketed, 20 HP.

1—H. K. Porter double worm mixer, 75 gal., 50 HP

2—Baker-Perkins #14, 50 gal. sigma blade jktd., geared both ends.

2—W. & P. 50 gal., sigma blade, non-jacketed.

2—Day 35 gal., sigma blade, non-jacketed, 5 HP.

1—Hottman 30 gal. double paddle mixer.

7—Baker-Perkins Barattes, jacketed, 52" dia. x 39" long, with drives.

12—French jacketed rayon mixers, 5' x 3' x 4', dbl. shaft.

1—Robinson 110 gal. semi-mass, T304 SS 75# jkt., 5 HP.

3—Stainless steel ribbon mixers: 425, 24, 15-cu. ft.

2—Paddle mixers, 250 cu. ft., T304 SS, jacketed.

2—Dunning & Boschert double paddle, 210 gal., 54" x 47" x 30".

1—Mueller continuous mixer, T347 SS 7" x 7" 3'9", jacketed, 75# IWP.

1—Worthington 70 cu. ft. rotary batch blender, 30 HP.

2—Baker-Perkins #K-300 "Ko-Kneaders", 150# jkt., 60 HP.

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4—Sharples Super-D-Hydrators, C-20 C-27, T316 SS, monel.
2—Sharples PN-14 Super-D-Canters.
7—Sharples #16, T304 SS.
2—Sharples #18V, vapor-tite.
1—Bird 18" x 28" horiz., T304 SS.
3—Bird 24" x 24", slotted screen monel.
1—Bird 24" x 38" horiz., monel.
1—Bird 32" x 50" horiz., T316 SS.
2—DeLaval #BUH-3930, T304 SS.

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1—11' x 155' Traylor, 7/8" shell.
2—8' x 170', brick lined.
1—8' x 125' Vulcan, 3/4" shell.
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80 sq. ft. Devine, UNUSED.
36 sq. ft. Stokes, Steel.
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2—5'3" x 3' Oliver, T316 SS, ASME 25#, 60 sq. ft.
1—10' x 12' Elmco, rubber-covered.
2—9'6" x 15' Oliver, rubber-covered.
1—8' x 8' Oliver, precoat.
1—6'6" x 6 Feinc, steel.
1—5'3" x 8' Oliver, precoat, UNUSED.
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REACTORS—FERMENTERS—KETTLES

1—1400 gal., T316 SS, ASME 175#, 65# jkt., agit.
2—750 gal. Fermenters, SS ASME 30# int. 30# jkt., 10 HP XP agit.
6—465 gal. reactors, T304 ELC SS, 150# int. 160# jkt.
1—450 gal. reactor T347 SS, 15# jkt., agit.
2—125 gal., T304 SS fermenters, ASME.
1—100 gal. T304 SS reactor, ASME vac. int. 75# jkt. UNUSED.
1—1000 gal. Pfaudler G.L. reactor, ASME 75# jkt., 25# int.
3—750 gal. Pfaudler model "R", glass, jkt. & agit.
1—600 gal. G/L reactor, jkt.
5—500 gal. Pfaudler G/L reactors, 25# int., 75# jkt.
1—30 gal. Pfaudler G/L reactor, 25# int., 75# jkt. Agit.
5—1800 gal. Steel Kettles, 180# jkt., paddle agit.
1—1500 gal. Steel Reactor, ASME 600# int., 150# jkt.
1—1000 gal., Dopp kettle, C.I., 25 HP Agit., ASME jkt.

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1—48" A.T.&M. susp., T304 SS perf., vapor-tite.
1—40" Bird, susp. steel, imperf.
1—40" Fletcher, susp. steel perf.
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1—30" Fletcher, susp., T304 SS perf.
1—30" Fletcher, underdriven, T304 SS.
1—26" Fletcher, underdriven, T316 SS.
1—26" Tolhurst, susp., steel perf.
1—12" Fletcher, underdriven, T304 SS.

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Hammer Mills & Pulverizers 3 to 50 HP
Ball & Jewell #2 Rotary Cutters & others
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Pebble, Jar & Ball Mills, Lab. to 6' x 8'.
Steel 3 Roll, 9" x 32", 12" x 30" & 16" x 40".
Lehman 4 Roll W.C. 12" x 36" Steel
Colloid Mills 1½ HP. & up
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Blystone 3000# horiz. spiral mixer.
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1—Baker Perkins SS jacketed double arm sigma blade mixer, 2¼ gal. working cap.
1—Blaw-Knox 400 gal. steel jacketed autoclave, 570# internal pressure, 85# jacket.

THE GELB GIRL—MARCH 1959

AUTOCLAVES, KETTLES AND REACTORS

1—100 gal. type 316 SS jacketed reactor, 150# internal pressure, 75# jacket with impeller type agitator.
1—Tippett & Wood 2500 gal. jacketed steel kettle
1—Columbia Engineering high pressure storage tanks, 2400 gal., 265# working pressure
1—18,000 gal. type 347 SS vertical tank
3—Pfaudler type 316 SS jacketed kettles, 750 gal.
2—Pfaudler type 316 SS jacketed kettles, 300 gal.
2—Van Alst SS jacketed reactors, 50 gal.

DRYERS

1—Proctor & Schwartz 2 truck dryer with stainless steel trays
4—Link Belt steel roto louver dryers, Model 207-10, 310-16, 310-20, 604-20
1—Buflovak double drum dryer, 42" x 120"
1—Stokes Model 59DS steel rotary vacuum dryer, 5' x 30'
1—Stokes double drum dryer, 5' x 12'
1—Louisville rotary steam tube dryer, 8' x 45'
1—Louisville SS rotary kiln, 30" x 28', complete
1—Stokes SS rotary vacuum dryer, 2' x 6'
6—Stokes steel jacketed rotary vacuum dryers, 3' x 15'
1—Louisville SS rotary dryer, 8' x 50'
1—Louisville rotary dryer, 38" x 40' type L

FILTERS

1—Oliver horizontal filter, 6'6"
1—Sweetland #3 SS filter
1—Niagara SS filter Model 510-28
1—Oliver horizontal filter, 3'
1—Feinc SS rotary vacuum string filter, 3' x 3' (NEW)
10—Shriver plate and frame filter presses, 12" to 42"
12—Sweetland #12 Filters with 72 SS leaves
1—Shriver rubber lined filter press, 36" x 36"

MIXERS

19—Robinson type 304 SS horizontal blenders, 255 cu. ft.
5—Baker Perkins double arm sigma blade mixers, 100 gal.
3—Robinson type 316 SS sigma type jacketed heavy duty mixers, 300 gal. 60 HP
3—Howes 40 cu. ft. rubber covered ribbon blenders
1—Leader SS jacketed 51 cu. ft. ribbon blender

MISCELLANEOUS

2—Heat Transfer Products steel bubble cap columns, 36" and 42" with 5 and 10 trays
1—Acme steel bubble cap column 42" dia. with 10 trays
2—Patterson Kelley, steel heat exchangers, 1000 sq.ft. each
6—Struthers Wells heat exchangers, 885 sq. ft.
1—Patterson Kelley steel heat exchanger, 427 sq. ft.
50—Steel heat exchangers from 15 sq. ft. to 400 sq. ft.
30—Struthers Wells SS heat exchangers, 650 sq. ft. each
1—Struthers Wells type 316 SS heat exchanger, 330 sq. ft.
2—Stokes tablet presses, Model T
1—Badger type 316 SS bubble cap column, 36" dia. with 8 trays
1—Badger type 316 SS bubble cap column, 42" dia. with 11 trays
1—Stokes Model DDS2 rotary tablet press
1—Struthers Wells SS calandria type evaporator, 365 sq. ft.
1—Swenson type 316 SS vacuum crystallizer, 3'6" x 12'
1—Swenson type 316 SS vacuum crystallizer, 2'6" x 12'
1—Bird type 316 SS 48" centrifuge
1—Swenson single effect evaporator, SS, 320 sq. ft.
2—Blaw-Knox steel distillation columns, 36" x 40' with 24 trays, complete, NEW

1—Vulcan type 347 SS bubble cap column, 4' dia. with 28 trays
10—Davis Engineering type 316 SS heat exchangers, 170 sq. ft. (NEW)
1—Dover Tank Co. horizontal 4000 gal. nickel tank, 30 psi.
8—Alco type 316 SS jacketed reactors, 3000 gal. complete with drive and Turbine agitators, 50 psi jacket

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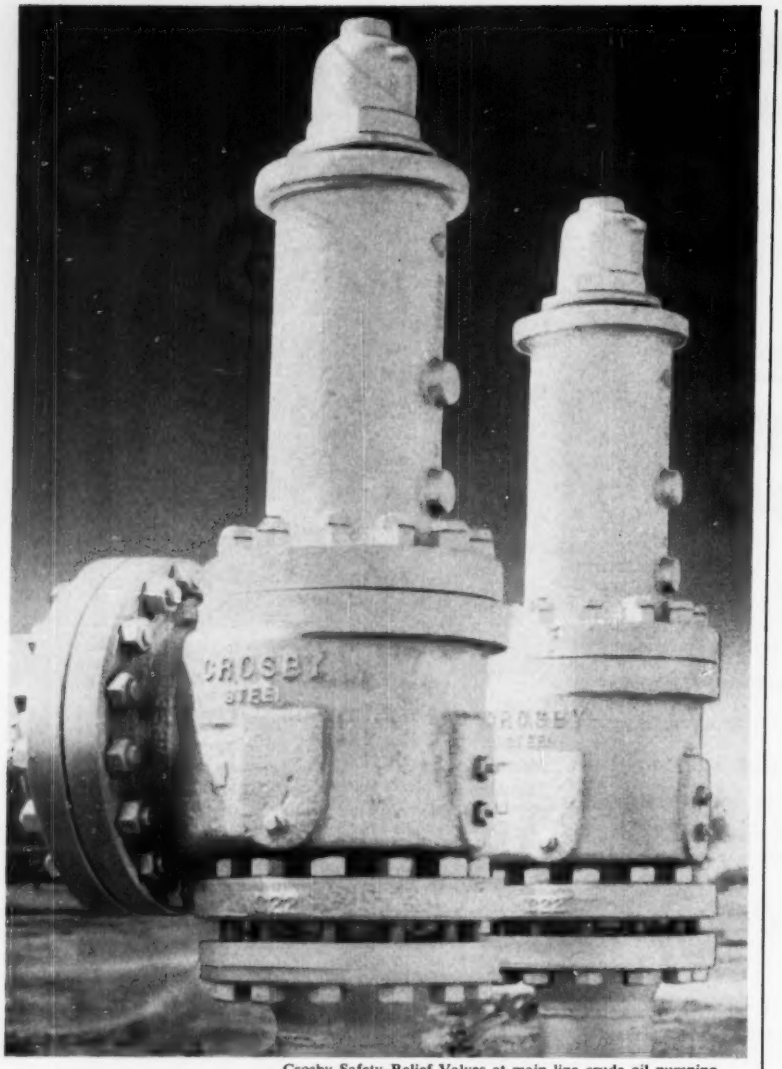

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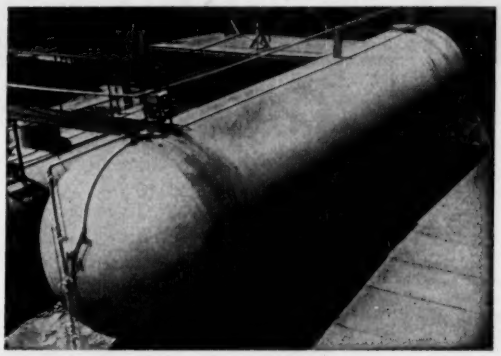

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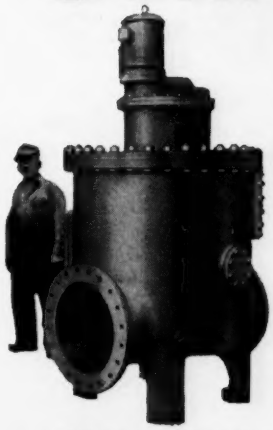

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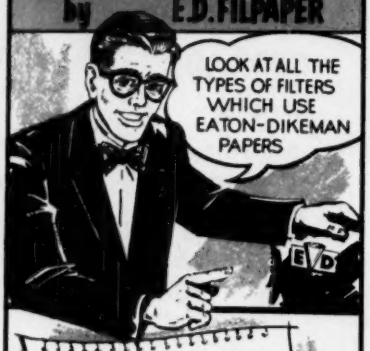

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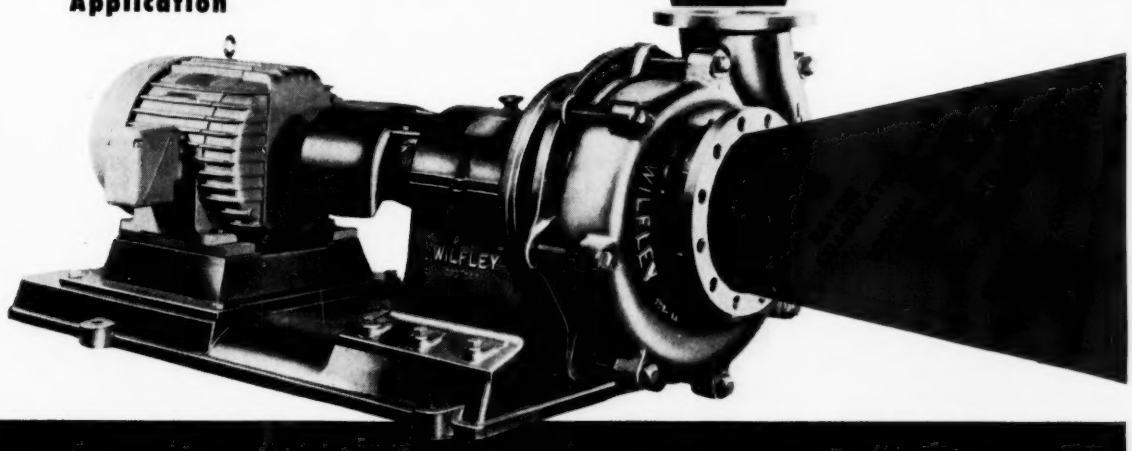

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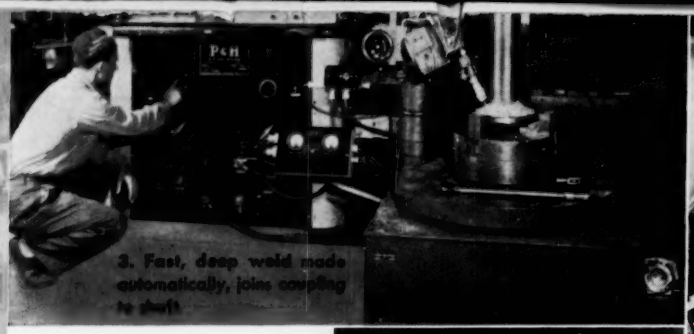
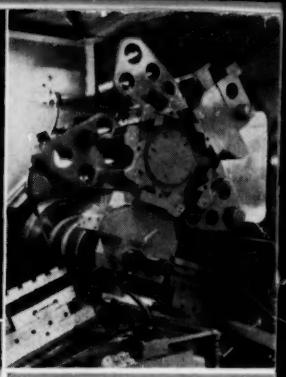
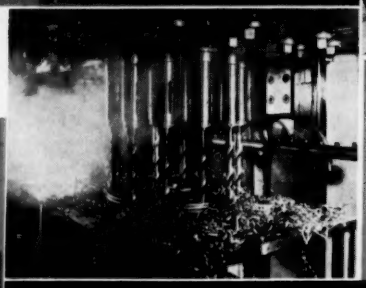


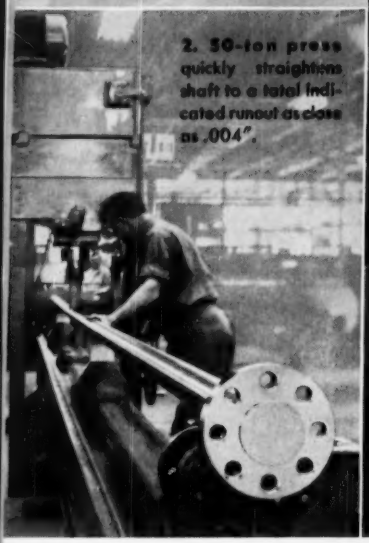
3. **Fast, deep weld** made automatically, joins coupling to shaft.



5. **Automatic lathe** with six cutters working at one station.

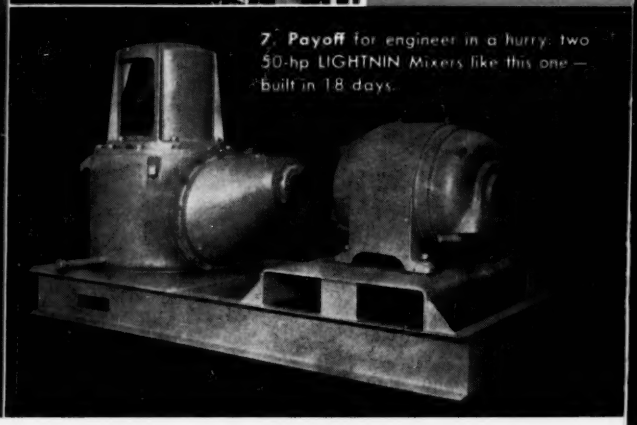


6. **Drill** makes 12 holes at once in a mixer mounting flange.



2. **50-ton press** quickly straightens shaft to a total indicated runout as close as .004".

4. **Mass assembly**—but every mixer is a custom job.



7. **Payoff** for engineer in a hurry: two 50-hp LIGHTNIN Mixers like this one—built in 18 days.

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Six tons in 18 days

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